SOUTHERN PACIFIC, SACRAMENTO SHOPS HAER CA-303
(Central Pacific Railroad Company, Sacramento Shops) *CA-303*
(Southern Pacific Locomotive Works)
111 I Street
Sacramento
Sacramento County
California

PHOTOGRAPHS

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WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
U.S. Department of the Interior
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HISTORIC AMERICAN ENGINEERING RECORD

SOUTHERN PACIFIC SACRAMENTO SHOPS
(Central Pacific Sacramento Shops)
(Sacramento Locomotive Works)
HAER No. CA-303

Location:	Sacramento, Sacramento County, CA
Date of Construction (extant structures):	Erecting/Machine Shop, 1869-1905 Boiler Shop, 1888-1905; Planing Mill, 1867-1869 Car Shop No. 3, ca. 1869 Blacksmith Shop, ca. 1869 Car Machine Shop, ca. 1888 Paint Shop, ca. 1873 Privy, ca. 1873
Architect (original site):	Woolaver and Wilkinson
Present Owner:	Union Pacific Railroad Company
Present Use:	Former Boiler Shop is presently used as California State Railroad Museum's Restoration Shop. Former Erecting/Machine Shop is presently used as storage for the museum.
Significance:	The largest and most comprehensive railroad heavy repair facilities in the Western United States, the unusually self-sufficient Sacramento Shops repaired locomotives and cars throughout its life and built new ones as late as 1937.
Historians:	Carolyn Dougherty, P.E. LeeAnn Bishop Lands, Ph.D. J. Lawrence Lee, Ph.D., P.E. Camille Vicenti
Project Information:	In summer 2001, the Historic American Engineering Record began a two-summer project recording the extant structures at the Southern Pacific Sacramento Shops. The first year's work documented the Boiler Shop and Erecting/Machine Shop. The second year's work documented the remaining six buildings on the site.

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INTRODUCTION

The Historic American Engineering Record's documentation of the extant structures at the Southern Pacific's Sacramento Shops offers a unique opportunity to analyze the process and transformations of a major railway's "backshop" business—the heavy repair functions necessary to keep a railroad and its rolling stock running efficiently. Little historical research or documentation exists on the heavy repair operations performed by U. S. railroads, even though numerous texts have romanticized rolling stock, steam locomotive operation, the "diesel revolution," and the transportation network itself. The paucity of data within HAER's own collection is no doubt due to the revamping of service and heavy repair shops that accompanied dieselization. Scores of erecting shops, roundhouses, and machine shops fell to allow for new or modified support systems for diesel technology, leaving little evidence of the steam locomotive manufacturing and repair system.[1] But, more generally, research into the day-to-day maintenance operations of the entire transportation industry—bus and truck lines, railroads, marine, and airlines—remains slim. This report on the Sacramento Shops expands the literature on railroad operation by

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[1] Not all HAER railroad shop documentation includes discussion of the heavy repair process. For discussion of other repair facilities, see the historical data in the following National Park Service, Historic American Engineering Record projects: "Monongahela Railway Company Shops," PA-218; "Wilmington &

documenting one of the railroad's heavy repair facilities for locomotives and cars, focusing particularly on the repair processes carried out in the Erecting/Machine Shop and the Boiler Shop, the two buildings documented in the first part of the two-year project, from its 1868 opening to its closing in 1999.[2]

The mid-twentieth-century replacement of steam power by diesel was a revolution for the traditional back shop repair facility, though changes finally made to the heavy repair process were not inevitable. Juxtaposing the steam and diesel eras reveals drastic differences in shop activities and practices. Where steam locomotive heavy repair remained essentially a job shop process into the 1950s, the fully-formed diesel locomotive maintenance system of the 1960s and 1970s incorporated many practices of industrial engineering and rational factories, introducing standardized dis- and re-assembly lines into buildings that had long housed machinery and men who custom made and fit parts to a wide variety of steam locomotives, most of which had been custom built to company specifications. But this "snapshot" view belies the difficult transition that the Sacramento Shops and the Southern Pacific, the Southern Pacific's successor company, navigated from the late 1930s to the early

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Northern Repair Shop," DE-13; and Central of Georgia Railway," GA-1; "Southern Railway Company: Spencer Shops," NC-8.

[2] The Sacramento Shops involved much more than locomotive upkeep, and included extensive car facilities, a recycling program that served the entire Pacific Division, providing parts for the company's steamship operations and bridges and, later, the Central Stores for the division.

1960s. A simple side-by-side examination of the two eras hides as much as it reveals. Indeed, the transition between the two eras is equally as significant, as it lays open an industry grappling to refine industrial processes.

The shops' original function, steam locomotive heavy repair, ranged from scheduled maintenance such as boiler cleaning and flue replacement, wheel changes, and the like, to repairs of serious damage incurred in wrecks and derailments. But the Sacramento Shops, while dominated by heavy repair operations, were in actuality an amalgam of retrofitting, manufacturing, and maintenance facilities. The shops never focused simply on repair, nor solely on manufacture, at any point in time. Master mechanics, superintendents, foremen, and workers introduced various innovations into equipment, or added new technological advances, such as air brakes, as they became available. They produced a variety of parts for the company's steamships, and for the central storehouse that supplied the entire system as well. They occasionally manufactured items for other companies too, even building a pump for the Sacramento Water Works.[3]

The varied activities of the steam-era Sacramento Shops are at once representative of heavy repair shops nationwide, and anomalous. While the piecemeal innovations developed and added to locomotives and cars at the Sacramento Shops followed a

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[3] D. L. Joslyn, "The Romance of the Railroads Entering Sacramento," *Railway and Locomotive Historical Society Bulletin* 48 (1939): 30.

process common to virtually all railroads, the Sacramento Shops were unusual in their level of self-sufficiency, as in their ability to found and re-use iron, which allowed for an unusually extensive recycling program. Though the shops were typical in their extensive use of job-shop production methods during the steam era, they later became a model of engineered production practices that other railroads emulated.

The transition to less-maintenance-intensive diesel technology resulted in the closing of many backshop facilities across the nation. Southern Pacific chose to maintain Sacramento as its principal overhaul site, but the transition to diesel maintenance challenged the company. While standardized locomotives and components offered an opportunity to standardize maintenance procedures, this was not the path initially taken. The transition, with a corresponding overhaul of shop facilities and equipment, took time, but the change was inevitable. By the end of the 1960s, an extensively revised plant provided standardized heavy repair to a locomotive fleet now noted for its similarities instead of its diversity. Cranes moved equipment from station to station, and new tools aided workers who performed a smaller variety of tasks.

During this transition, the basic nature of locomotive maintenance changed so much that it not only revised the physical plant and processes, but it also reshuffled the significance of long-established craft hierarchies, drastically altered the sizes of their ranks, and redefined the types of work each craft performed. Electricians, for example, played a minor role in the maintenance of steam power, but they moved into the predominate role of trouble-shooting and repairing the complex electrical transmission and control systems of diesel locomotives. Conversely, most boilermakers found little demand for their skills after the last fire was dropped. Machinists were still necessary, but many became more like mechanics who changed parts supplied by vendors instead of the craftsmen who actually fabricated those parts in-house. As the shops evolved, so did the workforce.

To understand the operations and transition of Sacramento's heavy repair operations, one must understand the larger workings of the original Southern Pacific (CP) and later Southern Pacific (SP) railroads. Corporate decisions, government policy, and the evolution of the railroad industry as a whole influenced shop development, and this report places changes in the shops within this larger context. Sacramento's shops operated within a network of government-imposed limitations, economic fluctuations, corporate culture, and technological frameworks that *all* impinged on shop operations at one time or another. Likewise, shop activity cannot be divorced from the day-to-day operation of the railroad, particularly during the steam era. The master mechanic, the division's chief mechanical officer, kept careful watch over both, as sloppy operation induced wear on locomotives and, in worse cases, major damage. Poor operation meant higher fuel consumption and more time in the shop, and poor maintenance meant on-the-road failures and train delays. Both meant higher costs and lost revenues.

This report is organized into three main parts. Because the functions and facilities used to build and maintain locomotives and cars are substantially different in many respects, each has its section. On the other hand, many of the work experiences and management practices applied to the entire shops complex, so operations and practices are covered in a third part. Following the main text are appendices that contain supporting information, including a timeline outlining the shops' history. Additionally, this project produced a set of drawings and large-format photographs that together comprise a comprehensive graphical record of the surviving portions of the Sacramento Shops.

PART I – THE LOCOMOTIVE SHOPS

MAINTAINING STEAM, 1869 TO 1958

Born in the age of steam technology, the Southern Pacific developed from a drive to push a railway across the Sierra Nevada. Collis P. Huntington, Leland Stanford, Charles Crocker, and Mark Hopkins, collectively known as the "Big Four," collaborated at mid-nineteenth century to build the western portion of the Transcontinental Railroad, and celebrations marked the January 1863 groundbreaking for the CP at the railroad's western terminus in Sacramento.[4] The Big Four would go on to subsume the Southern Pacific into the Southern Pacific and create a rail system so large it would invite government anti-trust action in the early twentieth century.

Steam locomotives operated on technology that evolved from Thomas Newcomen's atmospheric engine into the true steam engines of James Watt and ultimately made practical for railroad propulsion by individuals like Richard Trevithick and George and Robert Stephenson. Fireboxes burning wood, coal, or oil—SP used each at some point—produced hot gases that flowed through boiler flues and turned water into steam. When a throttle was opened,

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[4] Willliam Deverall, *Railroad Crossing: Californians and the Railroad, 1850-1910* (Los Angeles: University of California Press, 1994), 10-13.

this steam flowed to the engine's cylinders, where valves admitted it alternately to the cylinders' opposite ends to push pistons back and forth. Through a crosshead and driving rods, this reciprocating motion turned the locomotive's drive wheels and generated a substantial pulling force, or "tractive effort." Combined with the inherently low rolling resistance of iron wheels on iron rails (later steel wheels on steel rails), steam locomotives could haul unprecedented volumes of passengers and freight at previously unattainable speeds. The powerful new technology complemented the mood of an expanding America in the nineteenth century.

In 1861, three decades after the first American railroads began to run trains "back east," and five years after the Sacramento Valley Railroad, California's first rail line, had initiated service some twenty miles to Folsom, the city of Sacramento and the state of California—both anxious to support the establishment of a rail hub and large employer in Sacramento—deeded the newly incorporated Southern Pacific Railroad of California thirty acres of slough along the city's riverfront, as well as an adjacent marshy lake variously known as the Old Slough, China Slough, or Lake Sutter. By 1869, the CP had filled in twenty acres of the Old Slough and begun construction on what would become one of the most extensive railroad shop complexes in the West.[5]

Soon, a small group of shops was up and running, including the 29-stall, 378-foot-diameter brick Roundhouse, a 55-foot diameter, manually operated, iron Sellers turntable, and a 100-by-204-foot, 30-foot-high, brick Erecting/Machine shop. The Erecting/Machine Shop included a 50-foot, wooden crane supported by the western brick wall and a row of iron columns that ran through the center of the shop. Dave Joslyn described the crane operation as follows:

> Transverse motion was accomplished by an endless chain passing over sheaves at each end of shop and attached to both sides of crane. Motion was imparted to sheaves by belting and pulleys from overhead shafting. Hydraulic cylinders on crane, with chains passing over sheaves gave lifting power.[6]

By 1888, the wooden crane had been replaced by a steel one. Eleven pits lined the western portion of the shop, with the northernmost pit serving as a drop pit for truck removal.[7] Machinery filled the eastern portion of the building. The original ca. 1872 Boiler Shop, a wood and corrugated iron structure measuring 60 feet by 200 feet, was replaced in 1888 by

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[5] The CP purchased the Sacramento Valley Railroad in 1869 as well, a company that operated a 22-mile line from Sacramento to Folsom. Deverell, 16. Also see D. L. Joslyn, "Sacramento General Shops," n.p., 8, California State Railroad Museum library (hereafter referred to as "CSRM").

[6] Joslyn, "Sacramento General Shops," p. 16.

[7] By 1888, the drop pit had been removed to the Roundhouse. Joslyn, "Sacramento General Shops," 37.

one of similar construction, but 30 feet wider and 80 feet longer.[8] The second Boiler Shop was erected further to the west to allow for the addition of a 40-foot, steam-powered transfer table. Dave Joslyn described George Stoddard's original design of this transfer table as follows:

> [The plans] called for a table constructed of iron sills forty feet long, suitably braced with iron braces riveted together and supported on six pairs of wheels with three pairs front, three pairs rear of table. Motive power was a small two-cylinder steam engine . . . A pit between machine and boiler shops was provided to enable superstructure or frame of table to set below the level of tracks into the shops, thus bringing the transverse tracks on table to the height of tracks in shop. The total travel of table was 395 feet, and took in all pits in Machine shop.[9]

But dramatic increases in the weight, size, and amount of rolling stock pressed the company to continue expanding the shops. By 1892, the shops covered 17 acres and employed about 1800 men in the upkeep of the over 700 locomotives, 900 passenger cars, and 15,000 freight cars operating on the Pacific System.[10]

The shops' architecture was fairly typical of railway complexes of the era. The original Erecting/Machine Shop was a gambrel-roofed, masonry structure sporting cast-iron windowsills with cast-iron columns that were likely produced on-site. A roof

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[8] Joslyn notes that while management included a boiler shop in its original shop plans, it was not built until 1872 or 1873.

[9] Joslyn, "Sacramento General Shops," 45.

[10] Description of shops and system included in "Standard Firebox Arches of the Southern Pacific Railroad," *National Car and Locomotive Builder* (December 1892): 192-93. Southern Pacific Annual Report, 1892, 15. The shops as they

monitor allowed increased interior lighting, and the building's original wooden south end suggests that shop architects planned for future building expansion. Arched Italianate windows and stepped brick accents around the individual bay doors were typical embellishments included in this era's industrial buildings. The brick roundhouse to the northwest was erected on a granite foundation and such structures' arced design was considered inherently elegant. In stark contrast, the nearby original (ca.1872) and replacement (1888) Boiler Shops were wood and corrugated iron buildings devoid of embellishments. Though a less costly, fire-retardant alternative to brick that allowed for easy building expansions or modifications, rusting and decay soon marked these structures, and repairs were frequently required. While not evident now, management sought to beautify the general area as well by planting numerous palm and eucalyptus trees, the latter for their reputed health benefits.[11]

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appear in 1918 can be found in ICC Valuation Reports, NARA RG134, Engineering Field Notes, 1918. Southern Pacific annual reports are available at CSRM.

[11] Information on the original shop buildings can be found in D. L. Joslyn, "Sacramento General Shops," unpublished manuscript, CSRM. The Big Four utilized experienced rail men to help build their shops. Benjamin Welsh drew on his expertise in helping erect the Folsom Shops of the Sacramento Valley Railroad and his work with the Atlantic and St. Lawrence Railroad, the Grand Trunk Railroad, the Portland Locomotive Works, and the San Francisco and San Jose Railroad's Half-Way House (where he was master car builder) when he helped the CP install its Sacramento car shops. I. H. Graves, hired to oversee the mechanical work at the new Sacramento Shops, also hailed from Sacramento Valley's Folsom Shops. A. J. Stevens brought experience gained on the Burlington Route and other carriers. No doubt these leaders drew on their knowledge of other shops' layout and standard practice when they set up the Sacramento Shops. Also see Joslyn, "Romance of the Railroads," 25-26.

The shops performed both running and heavy repairs. Roundhouse forces did basic servicing operations, such as the replenishing of coal or oil, water, and sand; cleaning; and inspections of brakes, wheels and running gear.[12] Most running maintenance, such as routine adjustments, repair of minor damage, and periodic, legally required inspections, also took place in the roundhouse or on adjacent outdoor tracks. Heavy repairs, rebuilds, and modifications that kept an engine out of service for several days, or even weeks, were handled by the Back Shop, which included the Erecting Shop, Machine Shop, Boiler Shop, and a variety of supporting shops. These operations supplied much of the material and parts needed for both running and heavy repair, as well as for new locomotive manufacture from time to time. Few industries and capital goods manufacturers graced the California landscape, and shipping iron (later steel) parts and raw material from the East proved too costly and time-consuming. Thus, the Central Pacific established a brass foundry, a blacksmith shop, and even its own iron foundry to provide cast and forged parts for the machine shop to finish. A variety of components continually flowed from shop to shop on dollies, pushcarts, and the backs of laborers and helpers.

The largest component of the Sacramento Shops, the Back Shop complex, was designed in a transverse configuration common to

[12] Larry Mullaly, "Down at the Roundhouse: Southern Pacific Engine Service during the Age of Steam," SP *Trainline* (Winter 1998): 7-12.

most such facilities. The Back Shop's central feature was its Erecting Shop, a large, rectangular hall with parallel tracks and large overhead bridge cranes running perpendicular to the bay tracks. The Erecting Shop disassembled a locomotive and sent its components to the appropriate specialty shops for renewal, and then reassembled the engine from the rebuilt items.

Many of these components required final machining to fit them to a particular locomotive in the steam era, so the Machine Shop was located in the same building as the Erecting Shop. To an observer, it would seem to have occupied about half of the one big hall that included the Erecting Shop. Such an arrangement gave the machinist actually making a part direct access to the locomotive it was for, making it easy to obtain any necessary measurements as well as minimizing the intra-plant handling of many items. With the advent of diesels, the need for this kind of part fabrication diminished, but it certainly did not disappear, and the close relationship between the Machine Shop and the erecting floor remained. The Machine Shop also supported the Roundhouse, located to the north, by providing parts it needed for running repairs. Initially, this machinery was powered through a line-shaft system using flat leather belts to transmit power from the line shaft to individual lathes, boring mills, shapers, and other machine tools. The Machine Shop's line shaft was oriented in the north-south direction, and flat belts connected it to the Powerhouse and Blacksmith Shop. A 155-

horsepower Corliss steam engine with an 18-foot-diameter flywheel, located near the center of the site, turned line shafts throughout the shops. Facility growth required larger Corliss engines over the years, but electric power ultimately made the steam engine and line shaft obsolete.[13]

Although there were some changes as the shop complex expanded, the way locomotives being "turned" between runs or undergoing heavy repairs moved through it remained remarkably consistent throughout the steam era. Like virtually all other large steam-locomotive facilities, Sacramento began with a turntable that directed traffic in and out of a surrounding roundhouse. The turntable not only allowed engines to be routed to any of several tracks radiating from it, but it allowed locomotives to be turned around to reverse their direction of travel. Unlike diesels that pull and track equally well in either direction, most steam locomotives were designed to run primarily forward.[14] Thus it was necessary for roundhouse forces to turn them to face the direction the train for which they were called would head. In addition to tracks inside the roundhouse, where repair work was done, other tracks leading to the turntable

[13] For discussion of standard shop designs, see *Railway Shop up to Date* (New York: Crandall Publishing Co., 1907).

[14] **While diesels ran equally well in either direction and most multi-unit consists were usually arranged with a cab at each end, some turning of diesel units was still required, and Sacramento's turntable remained in service throughout the diesel era. In contrast, however, almost all steam locomotives rode the turntable to be properly oriented for their next train.**

passed by fuel, water, and sand facilities, as well as pits between the rails for running-gear inspection. With these "turning" operations complete, the locomotive moved to the ready track to await its outbound call. Locomotives made most movements in the roundhouse area under their own power, handled by hostlers who operated the engines and made sure their fires and water levels were properly maintained while on the ready track. By time diesels had replaced steam in the late 1950s, SP had moved most of its freight operations to the large yard at Roseville, a dozen miles northeast of the shops, and the simpler turning process for diesels allowed the road to relocate diesel running maintenance to an engine house there. Thus, these functions essentially disappeared from Sacramento in the 1960s, and the facility concentrated on heavy repairs.

The arrangement of the Back Shop was very different from that of the Roundhouse, reflecting the different nature of its work. It was laid out in a rectangular fashion, initially with parallel tracks entering the west side of the Erecting Shop. To streamline the process and allow for efficient expansion, SP installed a transfer table, a bridge-like structure that moved on rails perpendicular to the orientation of the track it carried, between the two major shops in 1888, along with tracks into the east side of the enlarged Boiler Shop. The transfer table could be aligned with any of the Erecting- and Boiler-shop tracks, and subsequent expansion to the east resulted in the transfer table becoming the only access to the Erecting Shop. Access to the transfer table was initially available at both ends of its pit, but subsequent Boiler Shop expansion eliminated the south-end access track. Once moved onto the transfer table, a locomotive's orientation did not change until it left the Back Shop area.

A steam locomotive headed for heavy repair arrived at the Back Shop dead, moved there by a small shop switcher called a "goat." The transfer table contained a winch to pull locomotives on and off of it, though winches in the shop often supplemented this. Since the engine would be out of service for some time, Roundhouse forces had already extinguished its fire, drained its boiler and, if necessary, turned it to face the direction the Back Shop needed. During the shops' first few decades, locomotives in the back shop usually faced toward the east, but this was reversed as locomotives grew larger. Facing east meant that engines had to be pushed onto the transfer table using long poles and pulled off using heavy chains or wire rope. With larger, heavier locomotives, the increased safety of coupling the goat directly to its front coupler offset any convenience of having the cylinder end of the engine closer to the Machine Shop, and the longer flues of the larger boilers could be more easily replaced with the Erecting Shop stall doors open to provide clearance. Back Shop forces would disconnect the locomotive from its tender, an operation that involved breaking numerous hose connections and removing a drawbar pin. The tender would be routed to the Tank Shop, located in the northern part of the Boiler Shop, for repair or rebuilding as necessary. The goat would then push the engine—sans tender—to the transfer table, which would then move south to align with one of the Erecting Shop tracks so that the engine could be pushed into that bay. Except for not having tenders or boilers to drain (except for the small steam generators on passenger units), diesel locomotives were later handled in essentially the same manner.

The shops functioned as more than just heavy and running repair facilities. They were part component factory, part locomotive manufacturer, and part industrial laboratory. From their inception in the 1860s until the end of steam locomotive operations in 1958,[15] the operations at Sacramento included running repair, heavy repair, batch (or even single unit) manufacturing, and technology development, and much of these activities continued with diesels until the shops finally closed in 1999. This combination of site functions presents a confused picture for those attempting to sort out processes—material transfer, production lines, and the like. What is more, the

[15] As is the case for many railroads, the last steam run on SP is open to question. The last "official" run on SP was a November 19, 1958, fan trip behind SP 4460, a 4-8-4. The last scheduled operation had SP 4430, also a 4-8-4, pulling a San Francisco commuter train on January 22, 1957. Steam operation continued on the Nacazori Railway, an SP subsidiary in Mexico, and over SP's narrow-gauge line into 1959, and a few engines may have been moved under their own power as late as May 3, 1961, when SP 2248, a 4-6-0, became the last steam locomotive to be removed from the roster. See Timothy S. Diebert and Joseph A. Strapac, *Southern Pacific Company Steam Locomotive Compendium* (Huntington Beach, CA: Shade Tree Books, 1987).

process arrangement changed constantly, and it differed according to the type of locomotive being maintained or manufactured. All of these efforts overlapped in the Sacramento Shops, but here they will be examined separately, beginning with the heavy repair process, to clarify how SP continually sought to improve maintenance efficiency.

Heavy Repair

The largest portion of the Sacramento Shops provided heavy maintenance and repair for locomotives.[16] After being spotted in the Erecting Shop, a locomotive's rods, pistons, valve gear, and journal box retainers were removed and inspected.[17] An overhead crane lifted the locomotive off its wheels and placed it on a set

[16] The American Association of Railroads and others helped establish a regular heavy maintenance schedule for steam locomotives in the 1920s. It is not clear what kind of regular schedule was in place before that, other than the ICC-mandated (after 1911) boiler cleanings and repairs. Class 5 inspections included renewal of drivers, engine and trailing trucks, renewal and turning of tires, and necessary repairs to machinery and tender. Class 4 included class 5 repairs plus a partial set of flues. Class 3 repairs included class 5, plus a full set of flues. Class 2 repairs included a new firebox, one or more new shell courses, or a new roof sheet, new or reset flues, new or turned tires, and general repairs to machinery and tender. Class 1 was a complete rebuild, including a new boiler or back end, new or reset flues, new or turned tires, and general repairs to the machinery and tender. SP established its scheduling system in 1924. Boiler washings were performed monthly and at annual ICC inspections. See Robert J. Church, *The 4300s: The 4-8-2s: The Story of Southern Pacific Mt Class Locomotives* (Wilton, CA: Signature Press, 1980), 65-67.

[17] Locomotives' increasing size as well as the greater demand for repairs necessitated Machine/Erecting Shop expansions. See Appendix I. In the Machine/Erecting Shop, breaks in the masonry where settling occurred indicate the points of building expansion.

of blocks on nearby tracks.[18] All parts were then removed, marked for identification and inspected. Parts in good shape were stored, while those needing re-finishing and repairing were distributed to various parts of the adjacent Machine Shop or to the Blacksmith Shop to the east. A boiler, for example, might be placed onto a shop flatcar spotted in an adjacent bay, and then moved to the Boiler Shop via the transfer table. Other components like the cab would be removed and set on the shop floor for repair,[19] while specialties like feedwater heaters and air brake components were sent to their respective shops for rebuilding. Other parts too damaged or worn for repair were replaced. When boiler removal was not required, boilermakers and machinists made the needed repairs on the still-intact boiler and frame assembly on the Erecting Shop floor. After days or weeks of repair, workers re-assembled the locomotive, lubricated the moving parts, and re-coupled it to its refurbished tender. The shop goat then moved the locomotive to the firing-up shed where the boiler was re-filled with water, hydrostatically pressure tested, and a fire re-kindled in the firebox. The locomotive, including tender, was finished with a new coat of paint before heading to the coal chute or oil plug, water tank, and sand

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[18] Carl Blakkolb interview, November 22, 1996, Sacramento Shops Oral History Project transcript, 7, CSRM (hereafter cited with interviewee's name and CSRM identification).

[19] Cabs needing extensive repair work usually received it in the Tank Shop.

house. After some running tests in the shop area and any final adjustments, it went back into service.

The process appears straightforward enough, but a number of factors complicated and slowed repairs. First, CP and SP continually upgraded their rolling stock, adding new types, and modifying others. Thus, few locomotives were exactly alike, and a standard system of repair was difficult to implement. Second, railroads lagged behind other industries in the adoption of jigs and fixtures to standardize parts. At CP, most components required machine finishing, even if a pattern had been used in the original fabrication. Additionally, as other authors have argued, locomotive standardization was hindered by master mechanics and craftsmen seeking either to upgrade power by experimenting with new technologies, or simply attempting to "leave their mark" by adding innovations or modifying designs. Finally, particular runs (like those traversing the Sierra Nevada) required special locomotives, or at least special components.[20]

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[20] References to special locomotive requirements for mountain grades or particular runs appear frequently. In one report on Master Mechanic A. J. Stevens, the writer noted that, "twenty five new [locomotives] have been made from his patterns. They are to be used to overcome the Tahachipa [sic] and Sierra." Later, the same writer remarked that, "an entirely new machine has been designed to meet the wants of the local travel in Oakland." *Nevada State Journal* (March 10, 1883): n.p. (article available at CSRM). John K. Brown discusses the influence master mechanics came to exert over design in *The Baldwin Locomotive Works, 1831-1915* (Baltimore: Johns Hopkins, 1995), 57-91. Also see John K. Brown and Samuel M. Vauclain, "Comments on the System and Shop Practices of the Baldwin Locomotive Works," *Railroad History* 173 (Autumn 1995): 103-141.

In fact, the introduction of new components or features was a primary function of the Back Shop. Master mechanics, foremen, and skilled workers tested and installed a variety of materials and innovations designed to add tractive power or cut fuel consumption or otherwise lower costs. In the era before engineers had added science to innovation, the bulk of technological progress, particularly in railroading, came from the shop floor.

Modifications

The machinery and skilled labor required to run SP's heavy maintenance facility also supported any modifications the master mechanic or management sought to introduce into rolling stock. The desire for increased tractive power and lower costs drove master mechanics to experiment with new materials and new components. New engine components developed in-house or by outside suppliers (as well as shop machinery) were tried often, and master mechanics, superintendents, and foremen tracked performance. Gangs installed experimental parts or modifications on one to five locomotives, carefully noting the engine number and related data, and then kept tabs on performance. In early 1901, for example, Master Mechanic H. Heintzelman sent a note to the Boiler Shop foreman,

> Referring to the boiler tubes that we are receiving from the Tyler Tube & Pipe Company, I wish you would give these tubes special inspection, and keep a close record of them when they are put into service giving the number of engine and the division that the engine goes to . . . These being a special brand of tubes we want to watch their performance very closely, as it is claimed they are the best tube in the market today.[21]

In 1895, H. J. Small noted that they had applied H. W. Jones and Company's fire belt blocks as lagging on one of the 10-wheelers and asked that Heintzelman compare its performance to other boiler lagging.[22] But craftsmen developed their own products in-house as well. In 1880, master mechanic A. J. Stevens announced the CP's development of a wrought-iron car wheel, a material Stevens argued was more durable and lighter than the traditional cast-iron wheel. The rim and hub were forged into two circular sections, leaving recesses for spokes. After fourteen spokes were added, the whole arrangement was heated and finished with three strokes of a steam hammer. A steel tire finished the wheel assembly. Stevens reported that the new forged wheel proved lighter by 250 pounds each, amounting to a 40-ton weight saving on a typical forty-car train.[23] Of course, not all methods

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[21] MM [Master Mechanic] to J. M. Dunnigan, Foreman, Boiler Shop, January 3, 1901, MS 10, CSRM (hereafter cited by letter, date, and MS 10, CSRM).

[22] H. J. Small to Heintzelman, March 16, 1895, MS 10, CSRM. In other cases, SP tried out American Balance rings & disks, Sargent cast-steel brake shoes, and a myriad of other products. See Heintzelman to Small, March 27, 1895, 29 March 1895, and April 25, 1895, MS 10, CSRM.

[23] "A New Wrought-Iron Car Wheel," *National Car-Builder* (March 1880): 43. A. J. Stevens was appointed Master Mechanic for the CP in 1869 and was responsible for a number of innovations the company incorporated into its purchased and in-house-manufactured locomotives. He is most widely known for his valve and valve gear design. See D. L. Joslyn, "Andrew Jackson Stevens,"

attempted were successful. In the 1880s, Stevens attempted to change ferry boilers from coal to oil fuel. The experiment was abandoned when fireboxes leaked and eroded more quickly than they had with coal.[24]

CP's management participated in the larger forum on technological and operational changes that took place at nascent professional organizations and on the pages of trade journals. Indeed, as historian Steven Usselman has argued, the relationships among railroads were more mutually beneficial rather than competitive when it came to developing improvements.[25] In 1885, for example, editors at *The National Car-Builder* compiled responses from master mechanics throughout the U. S. regarding the preferences for steel or iron in the making of fireboxes. A. J. Stevens told the virtual gathering that,

> During the past seven or eight years, we have used steel principally. Previous to using steel, we used Low Moor, Tennessee and other brands of iron. It is my opinion that Low Moor, Tennessee, or any other good iron will not deteriorate as rapidly from the injurious effects of bad water as will steel. In other respects, I believe steel to

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Railway and Locomotive Historical Society Bulletin 65 (October 1944): 8. For the valve gear, see also *Railway Age* 10 (June 25, 1885): 405.

[24] *National Car and Locomotive Builder* (February 1887): 15. Innovation was not limited to the Machine/Erecting Shop. Stephen Uren, who eventually became head of the Forge Shop, patented a process for making bolts and nuts from scrap iron, and another patent for a wrought-iron brake shoe. D. L. Joslyn, "History of the Sacramento Shops," *Western Railroader* 10 (March 1947): 7.

[25] Steven W. Usselman, "Patents Purloined: Railroads, Inventors, and the Diffusion of Innovation in 19th-Century America," *Technology and Culture* 32 (October 1991): 1047-1075.

> be superior. We have had some trouble with steel fire-boxes cracking, and have also had difficulty with iron fire-boxes blistering. The annoyance resulting from such causes is about equal.[26]

In another case, shortly before his death in 1888, Stevens sent prints of locomotives the CP was manufacturing at Sacramento to the *National Car and Locomotive Builder*. Calling particular to a valve gear he had designed, he commented,

> Thinking you might like to know something about what we were doing here I thought I would give you a little information. You will observe that the valve gear on these engines is entirely different from any thing heretofore used.

Stevens went on to explain the technological advances incorporated into these engines in detail.[27]

The management and introduction of change into locomotive design and operations was not simply the purview of the master mechanic, but a give-and-take among operators, laborers, and engineers. Master mechanics modified basic configurations or the set up of components, working with other railway men across the system to measure success, failure, and fine-tuning of operations. In 1899, for example, Heintzelman requested that mechanical engineer F. W. Mahl create drawings implementing a suggestion of the shops' air brake inspector. Heintzelman passed on that,

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[26] "Material Used for Boilers and Fire-Boxes," *National Car Builder* (December 1885): n.p.

[27] "Death of Mr. A. J. Stevens," *National Car and Locomotive Builder* (March 1888): 41.

> It has been decided by Mr. Small to carry out the suggestion of our General Air Brake Inspector relative to increasing the storage capacity of air onto our different classes of engines as they go through shops, and in order to comply with this in a somewhat uniform manner as to the size of reservoir, location, etc., it will be necessary to have a sketch or diagram outlining this arrangement.[28]

The next year, Heintzelman informed Rocklin foreman R. Maker that "while engines 1920 and 1923 were here yesterday I changed the exhaust pipe from air pump to lead into the bottom exhaust cavity of cylinder saddle for the purpose of reducing the severe action of this pump exhaust on the fire when engines are going down the mountain." He requested any feedback Maker could give him on the resulting consumption of fuel as the locomotive moved downhill. He continued, "I think it advisable to change all these engines, and will do so as fast as we can get hold of them here."[29]

Innovations often necessitated re-training of engineers and trainmen. After air brakes began their tenure on the lines, for instance, the Pacific System brakemen were formally trained in the new technology's operation. Such training not only improved operational efficiency, but it also enhanced safety.[30]

If SP management decided a significant innovation warranted introduction system-wide, or on certain classes of power, it

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[28] MM to F. W. Mahl, Mechanical Engineer, November 9, 1899, MS 10, CSRM.

[29] Heintzelman to R. Maker, Foreman, Rocklin, CA, December 29, 1900, MS 10, CSRM.

[30] Master Mechanic Heintzelman instructed Roundhouse Foreman J. B. Wright, on September 7 1899, to send extra brakeman over from 1 to 3 p.m. to receive instruction. Heintzelman to J. B. Wright, September 7, 1899, MS 10, CSRM.

could include the innovation on locomotives purchased new from the builders, but it often chose to modify existing locomotives at Sacramento. While locomotives continued their regular routine of heavy repairs, others would be brought in for new installations of air brakes, steel wheels and the like. Automatic couplers—introduced to help prevent the hundreds of injuries and deaths that occurred as a result of manual coupling—diffused through the Pacific System, beginning in 1898 as engines moved through the Sacramento Shops. But introducing new equipment was rarely a smooth process, and much trial and error continued until problems with processes and parts were solved. Heintzelman responded to J. B. Wright in October 1898, that,

> . . . to yours in regard to California Couplers giving us trouble on our engines. Will say that everything is being done to overcome this. The Sacramento engines being the first that we have applied couplers to, are the first, naturally, to experience trouble from.[31]

The company's 30 June 1899 annual report indicated that 54 percent of the locomotives had been equipped with automatic

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[31] MM to J. B. Wright, October 28, 1898, MS 10, CSRM. Wright apparently complained about the California Coupler not coupling to cars with Miller Hooks. Heintzelman explained that this problem would continue until the proper couplers had diffused more fully into the system. "There will, no doubt, be more or less trouble with them until the couplers are changed on the cars to conform to the couplers on rear end of engines." Here, again, the problem of relying on material from the East came up, and Heintzelman continued, "Patterns have been made for drawheads for the cars, and we have sent east for malleable iron castings for the passenger train equipment. This, of course, will take some little time to accomplish on account of the length of time it takes to get the castings from the east." MM to J. M. Clarke, Foreman, Sacramento Roundhouse, November 23, 1898, and November 25, 1898, MS 10, CSRM.

couplers.[32] By June 1901, 95 percent of the company's locomotives sported automatic couplers. By 1902, the company's annual reports still showed the continued addition of automatic couplers, but using Lone Star couplers instead of the California brand.

Heintzelman's report to H. J. Small that the 52 new fireboxes applied in 1900 were "a fair showing when we consider the amount of other work that has been handled in our Boiler Shop during this period," speaks to the level of activity the combination of repairing and upgrading created in the shops.[33] Yet the Sacramento Shops, while concentrating on heavy repair and modifications, were capable of much more. The site's foundries, forges, and expertise allowed the company to manufacture locomotives, a capability it drew on periodically. SP never manufactured locomotives for very long, but when locomotives with specific capabilities were not readily available, or prices were too high "back East," SP opted to produce its own power in the Sacramento Shops.

Manufacturing

[32] SP Annual Report, 1898-1899, 11.

[33] Heintzelman to H. J. Small, January 2, 1901, MS 10, CSRM.

CP and SP manufactured both locomotives and cars in-house, but not before a thorough consideration of the pros and cons. The road was a long way from the Eastern builders, and it had to become quite self sufficient in its early years, and the Sacramento Shops soon developed the skills and acquired or built the facilities needed to construct complete locomotives. Sacramento turned out its first locomotive, CP 173, a 4-4-0, in 1872. With such a resource at his disposal, CP Master Mechanic A. J. Stevens clearly preferred building in-house, as it allowed him to test his own (often successful) innovations designed specifically for the SP's mountainous terrain. But the company bought from outside manufacturers as well, depending primarily on the relative economics at the time. In April 1882, for instance, the shops constructed a Stevens-designed 4-8-0, CP 229, and he wanted to build additional copies at Sacramento. Upper management evidently saw things differently, since the *Railroad Gazette* reported that CP had ordered twenty-five 4-8-0s from Cooke Locomotive Works only six months later.[34]

SP's operating people put a premium on availability, quality, and suitability for the road's unique requirements, but the company's executives saw procurement decisions almost entirely in

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[34] *Railroad Gazette* 14 (July 14, 1882): 434. *Railroad Gazette* reported that the CP shops produced a 2-8-0 Consolidation engine [sic] that spring, "intended for service on Tehachapi Pass grades." Also see *Railroad Gazette* 14 (June 23, 1882): 383. On the Cooke order, see *Railroad Gazette* 14 (September 1, 1882): 547, and 26 (October 27, 1882): 668.

economic terms. Just prior to placing a large order for cars and locomotives in 1886, C. P. Huntington and Charles. F. Crocker (son of the "Big Four" Charles Crocker) again engaged the debate over in-house manufacture. Huntington questioned the ability of the shops to manufacture locomotives more cheaply than they could be purchased in the East. And the point, he stressed, was not about quality, but about price, as he had "no doubt" equally good engines could be produced in SP's own shops. He emphasized that, "it has been my impression . . . (and I am inclined to still believe that my impression is right) that the locomotives cost more built in our shops than when bought here [in the East]."[35] Huntington noted in another letter that locomotive prices in the East had escalated in the meantime and confirmed to Crocker,

> There is no question in my mind but what you had better build them, if you can do it at the figures you name. Of course I don't know what the prices may be at the end of two years, but the engines could not be built here at this time for much if any less price than you can get them for there and there would be the expense of getting them there beside.[36]

And there were larger issues to consider, he acceded, continuing that "My own impression is that the engines will cost you a little more than the amounts you mention, but if they should cost a little more the money will go to our people, which helps build

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[35] C. P. Huntington to C. F. Crocker, December 15, 1886. C. P. Huntington Letters, George Rantz Research Library, Syracuse University (available at Stanford University), series 2, reel 6.

[36] D. L. Joslyn, "The Romance of the Railroads Entering Sacramento," *Railway and Locomotive Historical Society Bulletin* 48 (1939): 30.

up different interest around us, and that is in the right direction."[37] C. F. Crocker concurred on the latter point and then promised to keep a careful tally of the cost of manufacture "from which we expect to show you that including cost of delivering locomotives here from the East, we have saved money."[38] Nevertheless, Master Mechanic A. J. Stevens contended that the company would have ordered its locomotives from outside builders if they could have been assured of immediate delivery. As it was, demand was brisk, and the shops had to build as fast as they could to keep the company supplied.[39]

This build-versus-purchase debate would continue at SP throughout most of the steam era. As John Brown described in his history of Baldwin, the locomotive business was largely one of feast or famine.[40] During good economic times orders for new power increased, which resulted in higher prices and longer delivery schedules. Conversely, both price and lead time shrank during leaner periods. While there was some variability in material delivery time and price, the overall cost of building a locomotive at Sacramento fluctuated much less than did the builders' prices. As a general rule, it fell somewhere between

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37 *Ibid.*

38 C. F. Crocker to C. P. Huntington, December 28, 1886, CP Huntington Letters, George Rantz Research Library, Syracuse University (available at Stanford University), series 1, reel 43.

39 *National Car and Locomotive Builder* (November 1887): 1.

40 Brown, *The Baldwin Locomotive Works, 1831-1915*, 31-34.

the manufacturers' extremes, so the buy-or-build question was fresh for each order.

Although most American railroads did not build their own locomotives, the SP's Sacramento Shops were by no means unique in manufacturing locomotives while continuing repair operations. After all, both functions required much the same machinery, and the SP was particularly advantaged in having its own foundry and rolling mill. With these the company could manufacture many of its own components, saving time and money over bringing such commodities in from the East Coast. The actual method of manufacture closely followed that of repair, drawing as it did on the work of auxiliary shops to produce the boilers, wheels, frames, cylinders and smaller components that ultimately converged in the Erecting Shop. The process itself was more complex, though, and worth outlining.

After draftsmen produced drawings of a locomotive and all its related parts and assemblies, needed components or raw materials were ordered from outside manufacturers, or produced in the various shops on site. Parts were gathered in the erecting shop, where the final assembly of the locomotive would take place. Once assembly began, the process proceeded in a more or less planned order, though last-minute discoveries of missing parts or continued machining and fitting of existing parts could continue to hinder progress. To begin, the Erecting Shop crane brought two side frames to the designated bay, followed by pilot deck castings, guide yoke crossties, brake fulcrum crossties, reverse shaft crossties, and rear hinge castings that were assembled onto the two side frames. The entire assembly was leveled and squared, after which the cylinders and saddle were mounted, aligned, and bolted to it. Other gangs then added a variety of components (often at the same time), such as valve gear brackets, springs and equalizers, reverse linkage, and brake rigging. With the frame essentially complete except for wheels, the boiler, fresh from the Boiler Shop, was lowered onto it and fastened with a rigid connection at the cylinder saddle and a flexible one at the firebox to allow for thermal expansion. In the meantime, the engine's wheel sets, which, depending on the particular design, consisted of a lead truck, driving wheels, and trailing truck, were lined up on a track in a nearby bay. The boiler-frame assembly was lifted by crane and, with the assistance of many workers, "wheeled," or lowered onto the waiting wheels and trucks. Once wheeled, the locomotive was fitted out with crossheads; drive and valve-gear rods; air compressor(s); water, steam, and air piping, insulation and jacketing over the boiler; a cab; and, as applicable, appliances like sand dome(s), headlight, bell, and feedwater heater. The completed locomotive was then pulled out of the Erecting Shop and mated to its tender, which had been built in the Tank Shop, painted, and prepared for service. Though workers followed this general routine, each different type locomotive built had its own distinctive features and, thus, its own unique fabrication procedure.[41]

But was it really cost effective for a railroad to manufacture its own rolling stock? Clearly, the SP's management at times deemed it so, as the company ventured into manufacturing in several discrete periods.[42] In-house manufacture was at least, in part, a response to a company's very immediate need for locomotives. In particularly demanding years, some railroads turned to their own maintenance shops for engines they could not get in a timely manner from the major manufacturers. The editors of *National Car and Locomotive Builder* remarked to this effect in

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[41] Steam locomotive assembly information was compiled from Brown, *The Baldwin Locomotive Works, 1831-1915,* and David Weitzman, *Superpower: The Making of a Steam Locomotive* (Boston: David R. Godine, 1987). Also see David Weitzman, *Locomotive: Building an Eight-Wheeler* (Boston: Houghton Mifflin, 1999).

[42] Debates over local manufacture of locomotives versus purchase from locomotive specialists like Cooke and Baldwin appeared in various trade publications, indicating that many rail companies (not just those secluded in the West) wrestled with the question. And a review of the arguments delivered suggests that different master mechanics and shop managers chose to manufacture or to purchase locomotives for different reasons. In 1880, one author summarized in a letter to the editor of *National Car Builder* that locomotive building by repair shops had at one time occurred in response to a depressed state of business, when repair shops had time and space to manufacture their own locomotives. Another party explained to the editors of *National Car Builder* that those arguing in favor of in-house manufacturing failed to take account of interest on cost of shops, interest on capital, depreciation, costs of patterns, and the like. In fact, the writer concluded, the only argument in favor of in-house manufacturing was that "a larger force can be kept at work in readiness for extraordinary repairs when needed." Another contributor to the same journal repeated that argument in 1884, going on to aver that railway shops' less-refined equipment and less-capitalized shops could not produce the same quality of work of which the specialized locomotive manufacturers were capable. What is more, manufacturing work was frequently interrupted by the needs of repair jobs—the railway shops' priority. See "Is it cheaper for a railroad company to buy or build its locomotives?" *National Car Builder* (February 1884): 15.

the late 1880s, stating, "when the demand for locomotives is unusually brisk, it always stimulates the production in railroad shops."[43] The editors estimated that the fifteen locomotive builders produced 1,912 locomotives in 1887, while the total output by railroad shops nationwide totaled 318 locomotives.[44] The SP joined several other companies in manufacturing their own power, in fact. In February 1888, the same journal reported that while SP built twenty-one engines in 1887, the Baltimore & Ohio had built thirty, the New York, Lake Erie & Western thirty, the Chicago, Rock Island & Pacific seventeen, and the Canadian Pacific eighteen.[45] While in-house locomotive manufacture continued to some degree until the end of the steam era, the practice gradually diminished as locomotives became larger and more sophisticated. Few roads, most notably the Norfolk and

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[43] "Locomotive Building in 1887," *National Car and Locomotive Builder* (January 1888): 12. *National Car Builder's* 1880 article put the opposite spin on the argument, commenting that the repair shops turned to outside builders when demand for locomotives was too great for them to produce enough in adequate time. See "Shall We Build or Buy our Locomotives?" *National Car Builder* (May 1880): 78.

[44] "Locomotive Building in 1887," *National Car and Locomotive Builder* (January 1888): 12.

[45] "Where New Locomotives were Built Last Year," *National Car and Locomotive Builder* (February 1888): 26-27. Similarly, locomotives that had become outdated often were rebuilt in company shops rather than scrapped. In early 1896, Superintendent of Motive Power H. J. Small requested estimates from Master Mechanic Heintzelman regarding rebuilding engine No. 1979. Heintzelman responded with confidence, noting that the shops had rebuilt several of this class engine, "giving them new boilers, changing valve gear from removing the independent cut off" and thus "making them a first-class engine." Heintzelman to H. J. Small, April 3, 1896, MS 10, CSRM. Heintzelman requested that Schenectady Locomotive Works install his patented air valves on a new ash pan ordered in 1899. Heintzelman to Ben Williams, Superintendent, A&SE Railroad Company, Bisbee, Arizona, October 7, 1899, MS 10, CSRM.

Western and Pennsylvania, built new locomotives after the late 1920s, though many companies continued to make major modifications to existing engines in their own shops that were almost as complex as new construction.

SP maintained a fully equipped machine shop in the Erecting/ Machine Shop building to support the varied activities of the Sacramento Shops. Machine tools, originally operating from steam-driven shafts and belts included lathes, boring mills, bolt threaders, planers, and shapers. These were typical of the equipment found in other railroad shops. Dave Joslyn reported that the original shop was quite simple. It included the machines shown in the following list:[46]

[46] Joslyn, "Sacramento General Shops," 20-21.

1	car boring machine[47]
4	No. 4 bolt-cutting machines
2	double-headed driving wheel lathes
1	truck wheel boring machine
1	12 in. slotting machine
1	8 in. slotting machine
1	36 in. planning machine
1	14 ft. engine lathe, 36 in. swing
1	10 ft. engine lathe, 24 in. swing
1	12 ft. engine lathe, 24 in. swing
3	small brass lathes
1	nut-tapping machine
1	12 ft. iron planer, 26x26
1	hydraulic press
1	hydraulic punch for ¾ in iron
4	upright drills
1	8 ft boiler roll, with handles
1	large power punch
1 set	spring rolls
24	iron screw jacks, large capacity
14	small screw jacks

Joslyn asserted that it was the decision to build ten new 4-4-0 locomotives in 1872, plus the need for ferryboat boilers, that pushed SP to finally erect a separate Boiler Shop in 1872. The Boiler Shop initially included the rolls, punches, and shears that had formerly been housed elsewhere. As in the Machine Shop, steam-driven belts and pulleys originally drove the machinery. A

[47] "Car boring machine" is a curious term that likely referred to a car wheel boring machine, a device that accurately bored wheel hubs to achieve the proper press fit on axles. Since a "truck wheel boring machine" was also listed, it appears that two similar machines were desired, the former intended for car wheels, and the latter strictly for locomotive and tender truck wheels. Steam locomotive drive wheels had renewable rims, called "tires," as did some pilot truck wheels. These were rarely removed from their axles, so a specialized wheel boring machine for them was not required. The tires were trued on the "double-headed driving wheel lathes," which machined both wheels on an axle at the same time.

hydraulic riveter was soon added to the west side of the building. Hydraulic cranes moved heavy materials until an overhead crane was installed about 1917. Later, air hammers were introduced. Within this building, new tanks, tenders, locomotive cabs, and smokestacks were created, or old ones repaired. Not restricted to railroad use, the Boiler Shop workers also fixed and built ferryboat boilers for the SP's fleet.[48]

Growth in the 20th Century

At the turn to the 20th century, the combined forces of industrial development and the leadership of railway baron E. H. Harriman led what was now the Southern Pacific toward rapid system and equipment expansion, a growth ethic that found

[48] When the company opted to build a new boiler shop, the older structure was moved west and used as a brass foundry and spring shop, and even later as a tender shop. It is unclear when the first overhead crane was introduced. Joslyn, "Sacramento General Shops," 21, 28. In another manuscript, Joslyn describes the difficulties of working in the Boiler Shop. He penned that "those of us who had to repair the tanks, to crawl around in those hot dirty little tanks placing dash plates back in place, putting on a patch here and there; well, when we got done, we were hot, dirty and tired. And the boilers were so small, it seemed that a good sized blow fly could hardly get into them. But we had to get in the front end to take out flues, and had to get into the 2 x 4 fire box to replace stay bolts and make repairs." In another discussion Joslyn recalled, "I was put to work driving rivets on the new oil tanks that were being built for the tenders as the company was converting their locomotives to oil burning. Three apprentices and one helper would rivet the tanks after the boilermaker had fitted the sheets to gether [sic]. We had special made hand hammers, and had to pound those half inch rivets down tight and round the ends up in cone shape. No hitting the tank or making marks on it, and those rivets had better be tight and well shaped or we would hear about it." D. L. Joslyn, "Forty Six Years with the Southern Pacific," n.p., CSRM.

expression in Sacramento with a massive shops enlargement.[49] When Harriman, notorious for his drive to expand the Union Pacific and hailed for his management prowess, finished his acquisition of Southern Pacific stock, he controlled one of the largest transportation systems in the world—a railroad system that covered one-third of the United States, complemented by steamship lines that reached as far as Asia. SP operated almost 3,000 locomotives on over 8,600 miles of rail line in June 1901. But, as economic historian Lloyd Mercer points out, SP had been successful not because of well-run operations, but despite an inefficient system. While SP's gross revenues ran 79 percent larger than Union Pacific's, the company's capital earnings were only 40 percent larger.[50]

Harriman soon appointed Julius Kruitschnitt, an engineer who had formerly managed SP's lines in Texas, to be director of maintenance and operations. In this role, Kruitschnitt oversaw all new construction on both UP and SP, designing them to work efficiently together as a single coordinated system. Kruitschnitt also expanded SP's practice of gathering data on expenditures and work done, developing a reputation for his

[49] Harriman had been attempting unsuccessfully for some time to buy the Central Pacific, which had been leased to SP since 1885. When Henry H. Huntington was not elected to succeed C. P. after his death in 1900, the family decided to sell its stock, and Harriman's Union Pacific soon held 45 percent of the company. See Lloyd J. Mercer, *E. H. Harriman: Master Railroader* (1985), and Klein, *E. H. Harriman*.

obsession with statistics. This merged well with Harriman's insistence on cutting waste by slashing the large variety of parts, and a director of purchasing was added to the organization to help standardize buying for the entire system.[51]

With Kruitschnitt's appointment, SP launched an $18 million improvement program, upgrading roads, smoothing out steep grades, and beefing up rolling stock.[52] The increase in rolling stock joined with larger and heavier locomotives to place greater demands on repair facilities, and in 1904 the company reported an increase in repairs and renewals of 18 percent over the previous year. Harriman and Kruitschnitt enlarged a number of the Pacific System repair shops in the first decade of the 20th century in attempts to square their operations with the more smoothly operating U.P. They spent $168,500 to add an additional 18-stall engine house, a paint shop, and a car repair shop at Houston, Texas. Oakland, California, gained a 32-stall engine house and a boiler shop. Roseville, California, added an additional terminal yard, a machine shop, and two engine houses with 32 stalls each, totaling $375,000 in improvements.[53]

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[50] Lloyd J. Mercer, "Dissolution of the Union Pacific-Southern Pacific Merger," *Railroad History* 104 (Spring 1991): 54. Harriman rebuilt both lines and facilities, bringing the organizational order of the UP to the SP.

[51] Frog patterns, for example, were cut from 50 designs to four. Hofsommer, 26-29.

[52] Klein, 155.

[53] SP Annual Report, 1905-1906, 14. SP Annual Report, 1906-1907, 18. By June 30, 1908, the company reported the total expended on Roseville

The Sacramento Shops also benefited directly from these improvements; a new erecting shop was added to the west side of its existing Erecting/Machine Shop in 1905 (bricking in the south end the next year). The Erecting Shop addition both lengthened the track and pit space available for the larger locomotives and allowed the upgrading of the Machine Shop. More equipment could be introduced, and more space allowed for maneuvering of unwieldy parts. With the Erecting Shop addition, space formerly allocated to locomotive pits held the larger equipment. A 70-inch and 60-inch planer and a 76-inch lathe that measured almost 50 feet in length were moved into the new space, and other planers, boring machines, and shapers were added to the machine stock. The eastern section of the building remained relatively congested, though, with the center bay kept clearer for materials transfer and machines that worked larger and more cumbersome parts.[54] Likewise, the Boiler Shop required expansion, and in 1899 Heintzelman recommended to Small that the shop be widened by 26 feet on its east and west sides, and that a 20-ton electric traveling crane and better tools be added. But heavier and larger locomotives would continue to press shop capacity,

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improvements at $636,700. On the Harriman reorganization, see Maury Klein, *The Life and Legend of E. H. Harriman* (Chapel Hill: UNC Press, 2000), particularly chapters 17 and 18. Also see Don L. Hofsommer, *The Southern Pacific, 1901-1985* (College Station: Texas A&M University, 1986), 26-31.

[54] SP numbered its shop equipment, so with multiple plans one can see how equipment was rearranged over time, or how long particular machines were in use. Note that some plans are missing from the CSRM collection, however.

necessitating turntable enlargements and drop pit installations over the next few decades.[55]

The transfer table was improved in 1905 as well by converting it to electric power, using a 25-horsepower streetcar traction motor. The length of the pit was also increased to 544 feet to accommodate the larger Erecting Shop. This did not, however, address a nagging day-to-day problem, people walking between the Boiler Shop and the Erecting Shop. Unless the table happened to be spotted nearby and unoccupied, one had to walk all the way around the pit. Commonly, men would choose to jump down into the pit to cross, but they had to climb out the other side, and it was difficult to do this while carrying anything. It could also be dangerous if the table started to move. The solution, installed in 1910, was quite innovative, so much so that its inventor had received a patent.[56] SP engineers designed a new table that had most of its structure below ground level. The transverse beams carrying the table's track fit into slots

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"Plans of Machine and Erecting Shops, Book 814, Drawing 5240, August 25, 1905, CSRM.

[55] Heintzelman to H. J. Small, October 22, 1899, MS 10, CSRM. SP Annual Report, 1903-1904, 17. By the late 1920s, for example, the shops needed a larger drop pit to accommodate the latest engines, and in 1929 a new double pit was installed in the roundhouse. The *Sacramento Bee* reported that "The pits were necessitated from the fact that the ten new locomotives of the AC-4 type, known generally as the 4100 type, are too heavy to be lifted by the huge cranes in use in the Southern Pacific shops, which handle all ordinary locomotives used by the system with ease." *Sacramento Bee* (January 1, 1929). Heavier locomotives meant that the transfer table's 25-h.p. motor also had to be replaced with a 50-h.p. motor. The same problem—increasing locomotive size—mandated that the turntable and transfer table be enlarged in 1942.

running parallel to the rails on which the table moved. All of the old pit except for these slots was filled in, leaving a smooth surface essentially at ground level. At 44 feet in length, this table was slightly longer than the one it replaced.[57] By 1940, locomotives had grown considerably in size. The largest 4-8-8-2 articulated engines had wheelbases in excess of 60 feet. To accommodate them, SP's engineers designed extensions for each end of the transfer table that lengthened it to 70 feet. New rails and slots were added to suit the extended table, and a new 50-horsepower motor and drive improved reliability. The modified table entered service in 1945.[58]

Southern Pacific's business success of the first years of the twentieth century was challenged by shipping through the new Panama Canal after 1914.[59] That same year, the company suffered additional setbacks from the initiation of war in Europe, and

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[56] U. S. Patent No. 835,015 was issued to Fred S. Edinger on November 6, 1906. The table installed at Sacramento in 1910 had only minor differences in detail from the design shown in the patent drawings.

[57] See SP Drawing No. Special 7900, "44 Ft. Transfer Table (Locomotives)," April 30, 1910, CRSM.

[58] See SP Drawing No. 22182, Book 815, "70 Ft. Transfer Table, Locomotives," September 4, 1941, CSRM.

[59] Corporate officers expressed much concern over the competition the canal might bring, and in 1915 their fears proved warranted. Management explained to stockholders that "since the opening of the Panama Canal, August 13, 1914, competition has been intensified and the gross revenue of the lines of this Company has been considerably reduced by a large increase in the number, capacity, and sailings of steamships between Atlantic and Pacific ports, which, by a material reduction of rates, have taken a substantial volume of freight that was formerly shipped over transcontinental railroads." See SP Annual Report, 1915, 18. Also Vincent Grey Sanborn, "Genius of Kruitschnitt Guides Southern Pacific," *New York Evening Post* (October 4, 1924), reprinted in the Southern Pacific (SP) *Bulletin* (November 1924): 11.

operating revenues fell by 6.25 percent.[60] By 1917, though, these same factors were working to SP's advantage. Steamship freight hauling was partially suspended due to war demands, meaning that traffic was diverted back to the railroads for a time. This business was augmented by increased war production, raising operating revenues for 1917 by 18.69 percent over the previous year.[61] But 1917 ended with the United States engaged in the conflict, and the government having nationalized the railroads under the United States Railroad Administration (U.S.R.A.) in the name of national defense.[62] Nevertheless, war meant business, even if it was controlled by government, and by the end of the year the company had announced plans to construct $300,000 in new locomotives, all to be built at the Sacramento Shops.[63] SP went on to place orders for fifty-seven locomotives for delivery in 1918, with plans to build fifty-six more in the company shops, as builders could not provide all that were needed.[64] Those plans quickly changed, though. Locomotive purchasing and building were put on hold when the U.S.R.A. forced the company to purchase 1,000 boxcars to support defense traffic.

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60 *Ibid.*

61 SP Annual Report, 1917, 8.

62 SP Annual Report, 1917, 26. Also J. H. Dyer, "How the SP is Seeking to Improve its Service," SP *Bulletin* (August 1920): 7.

63 *Sacramento Bee* (September 26, 1917).

In the place of locomotive shop upgrades, car repairing and manufacturing facilities were expanded and upgraded over the next three years.[65]

As World War I drew to a close, the shops slowly moved back into normal operations, and thirty-seven locomotives were finished or in the process of completion by the end of 1920.[66] That same year, the U.S.R.A. was dissolved, and the railroads returned to private control, but the Transportation Act of 1920 that accomplished this also gave sweeping regulatory power over the railroads' services and rates to the Interstate Commerce Commission. Renewal of normal transportation functions nationwide also meant an escalation of competition with other modes. Freight shipments by steamship through the Panama Canal, exacerbated by rate wars between shipping companies, again threatened SP. The volume of tonnage shipped through the canal increased nearly 100 percent in 1922 over 1921.[67]

Business projections for the 1920s encouraged Southern Pacific to launch a ten-year program to expand car and locomotive building, growth that would require a concomitant repair shop

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[64] SP Annual Report, 1917, 18. H. C. Venter, "Sacramento Shops Have Built 143 Locomotives," *SP Bulletin* (November 1925): 5.

[65] Car Shop No. 3 was revamped in 1918. A 163-by-143-foot car repair shop was completed, and the car wheel facility was expanded to add 100 additional annealing pits. SP Annual Report, 1918, 10 and 24. SP Annual Report, 1919, 18. SP Annual Report, 1920, 20. SP Annual Report, 1921, 20.

[66] SP Annual Report, 1921, 20.

[67] SP Annual Report, 1922, 7-8.

expansion. Indeed, nationwide, railroads had been put in something of a holding pattern during the war, unable to commit adequate resources to rolling stock upgrades and maintenance. Equipment had seriously deteriorated, a point about which SP's leaders complained bitterly. Railroads from coast to coast spent the boom years of the 1920s renewing their rolling stock, and then expanding their resources. SP projected the acquisition of $12 million worth of cars and $3 million in locomotives, with 60 percent of the cars and 70 percent of the engines to be manufactured in the Sacramento Shops. At the shops itself, the company drew up plans for a new iron foundry, rolling mill, steel foundry, and general stores. Other buildings would be moved and expanded.[68]

The company's strong relationships with suppliers of raw materials and locomotives that marked the late 1800s continued throughout the 1920s. Southern Pacific worked closely with component manufacturers, testing materials or contributing

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[68] SP slated the new 4-8-2 Mountain locomotives for passenger service across the Sierra Nevada. Each locomotive priced out at $86,500 and, with tender, measured 97 feet, 6 inches in length and weighed 610,300 pounds. *Sacramento Bee* (December 23, 1926). Building plans were not limited to locomotives. The company spent over $2 million expanding its box and flat car supply in the 1920s. *Sacramento Bee* (December 23, 1926). *Sacramento Bee* (June 11, 1928). *Sacramento Bee* (July 23, 1920). The 1923 phase of expansion included oxygen manifolds, an oxy-acetylene gas plant, and a $311,000, 43,750-square foot Planing Mill. The old Planing Mill was to become an adjunct to the Machine Shop after the new one's completion. The oxy-acetylene building was designed to replace movable generators of welding and cutting gas. *Sacramento Bee* (January 5, 1924). The company would experiment with various ideas for both the extent of expansion and arrangement of buildings. According to the *Bee,* the Roundhouse was supposed to be moved to the south end of the yard, but this move never took place.

feedback to manufacturers developing new products. In the mid-1920s, such an exchange brought a one-piece cast steel engine bed into being. Intended for SP's new 4-8-2 Mountain type locomotives, the cast-steel bed combined all of the individual pieces that made up a locomotive's frame and cylinder block into a single, unified casting with greater strength and rigidity.[69] Likewise, SP maintained close ties to locomotive suppliers, testing, for instance, a new booster and feedwater heater for Baldwin on one locomotive in heavy passenger service. The booster engine, geared to the trailing truck axle, assisted the locomotive in starting heavy trains and accelerating to road speed. Newly developed feedwater heaters, introduced as fuel-saving devices, pumped water from the tender and used exhaust steam to heat it before it entered the boiler. After the additions proved their worth, SP had Baldwin install both appliances on fifty locomotives ordered from the builder in the early 1920s.[70] Likewise, in 1925 SP announced that the American Locomotive Company (Alco) had been contracted to build sixteen new 3-cylinder locomotives, designed for use over the Sierra Nevada. Mechanical Engineer (later Superintendent of Motive Power) F. E. Russell and his team developed the original design

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[69] Commonwealth Steel Company (Granite City, IL) developed the single-piece frame with integral cylinders after five years of research and testing. "One-Piece Engine Beds for Big Locomotives," *SP Bulletin* (October 1926): 8.

[70] "New Devices for Locomotives," *SP Bulletin* (August 1922): 25.

for the new 4-10-2 locomotives, with Russell himself working alongside Alco's engineers for several weeks in Schenectady, New York, refining the design. In recognition of the role of the company, Alco named the new wheel arrangement the "Southern Pacific" type.[71]

If the 1860s to World War I years were defined by the creation and maturation of SP's manufacturing and repair system, the 1920s to 1940s era was defined by sheer growth. Indeed, there were few alterations in how the shops worked over this 20-year period. They expanded to catch up on delayed repairs to ageing equipment and for the increase in in-house manufacture during the 1920s. Significantly then, little changed in this central shop arrangement or process from the 1860s, when the Sacramento Shops were established, to the 1940s, when diesel maintenance began to take over spaces formerly allocated to steam. To be sure, roofs were raised, spaces expanded, or buildings moved, but nothing changed the fundamental process arrangement. This is important, as it suggests that, like capital goods manufacturers, heavy repair facility managers did

[71] "'Southern Pacific Type' Locomotive Designed," *SP Bulletin* (February 1925): 3-4. While numerous locomotive improvements occurred during the 1920s, recovery after the 1930s depression saw the launch of car modernization programs designed to both upgrade the fleet and attract passengers that had increasingly defected to private automobile travel. Air conditioning, new interiors, refurbished chairs, and the like were added in a 1935 improvement program that promised to continue SP's 1920s business successes, despite the stagnant economy that launched the decade. "Southern Pacific Plans $125,000 Shops' Program," *Sacramento Bee* (November 23, 1934). "Comfort," *SP Bulletin* (October 1935): 10-11. "Work," *SP Bulletin* (December 1935): 6. "Polish," *SP*

not seek to cut costs by rationalizing materials transfer or standardizing the repair process. Instead, Southern Pacific sought to cut costs through other measures. This is evident in the company's efforts to alleviate damage to locomotive parts, its adoption of new fuel-saving devices, its training engineers in better train-handling techniques, and its documentation of water and fuel usage. As such, railroads like SP—previously known for their business innovations—stood firmly entrenched in older shop practices while other industries nationwide extolled the virtues of scientific management and industrial engineering. In fairness to railroad managers, though, the stringent accounting rules imposed by the I.C.C. strongly discouraged change.

This is not to say that SP and the Sacramento Shops were stagnant in their technological development. Indeed, the system worked, at least during this era. The company's job shop innovation methods allowed for road testing of new materials and new technologies. Mechanics were encouraged to suggest improvements, and they were involved in testing and assessment. Careful record keeping allowed superintendents and master mechanics to track test results and adopt only proven devices or procedures. Better locomotive performance, lower costs, and fewer repairs were direct results of the process. At the same

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Bulletin (December 1935): 7. "Jobs," *SP Bulletin* 20 (March 1936): 2-3. "Chairs," *SP Bulletin* (September 1936): 4-5.

time, the process allowed the development of a wide array of locomotives, with different types filling the needs of different terrains. The system, flexible though it was, did have its drawbacks. An increasing variety of parts was needed to service the various locomotive types and classes scheduled for heavy repair, and individual machining was frequently required to get an exact fit. All of this drove up repair costs.

Even while SP continued to expand its steam operations from the 1920s to the 1940s, a new technology that would revolutionize railroad operations emerged. Diesel power first caught the attention of Julius Kruitschnitt during the 1920s. The standard designs and interchangeable parts of diesel locomotives would give SP the opportunity to refine its production scheme by installing conveyors, teardown and assembly lines, and automated equipment to cut costs and quicken overhauls. Surprisingly, this

DIESELIZATION: A WHOLE NEW SYSTEM

Southern Pacific would capitalize on its relationships with locomotive builders developed during the late 1800s and early 1900s to cultivate diesel technology. According to historian John B. Garmany, it was SP and Julius Kruitschnitt that made the first move by an American railroad toward main-line dieselization when, about 1922, Kruitschnitt approached Samuel M. Vauclain, then president of Baldwin Locomotive Works, expressing his interest in the development of a 1,000-horsepower diesel locomotive.[72]

This may have been the earliest case involving realistic specifications for a diesel locomotive, but it was not the SP's first involvement with internal-combustion power. E. H. Harriman investigated at least two concepts for internal-combustion propulsion almost two decades earlier, and he purchased one of them. German engineer Rudolf Diesel built his first compression-ignition engine in 1893, and he had developed it into a practical power plant by the early twentieth century. Hearing of Diesel's work, Harriman met with him about 1904, and they discussed the idea of a diesel locomotive. At the time a diesel engine turned out to be too large and cumbersome for installation in a locomotive, and no good transmission was yet available, so the idea languished.

The spark-ignition gasoline engine developed by Nicolaus Otto held more promise. In 1905, the UP's Superintendent of Motive Power and Machinery William R. McKeen built a passenger car in the company's Omaha Shops powered by a 100-horsepower gasoline engine that drove the front axle through a Morse silent chain. E. H. Harriman believed strongly in the car, and the UP underwrote the establishment of the McKeen Motor Car Company

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[72] Garmany, 55.

three years later to build the cars in a portion of the Omaha Shops. With its all-steel construction (except for the wooden prototype), wedge-shaped prow, and round windows, a McKeen car looked futuristic, and it promised to substantially reduce the cost of passenger service on lightly traveled routes. The concept was sound, but the cars suffered from insufficient power and poor reliability. Nevertheless, McKeen built over 150 cars, about one-third of which went to UP and SP, but repeat buyers were few, and the company closed its doors in 1917.[73] Both SP and UP purchased motorcars from other builders in the years that followed, most of which incorporated electric transmissions that proved to be quite successful. While these were not locomotives *per se*, they did introduce both roads to the new technology.

The diesel locomotive possessed decided advantages over the steam locomotive. In a diesel engine, the compression of air supplied the heat to ignite fuel into its cylinders. The diesel engine then drove an electric generator, which supplied electricity to traction motors that turned the locomotive's wheels. Compared to steam locomotives, diesel locomotives started up and shut down easily, and they required less maintenance. But it was the diesel's potential fuel savings in particular that attracted Kruitschnitt. SP wanted greater power, too, and the ability to use multiple engines with only one engine

[73] William W. Kratville, "Knife-Noses and Portholes," *Trains*, July 1960, 30-34.

crew to move heavy trains over mountain grades was an attractive feature.[74] Only later would railroaders come to truly appreciate the advantages of standardization and its concomitant reduction in maintenance costs that diesels offered.[75]

But for all of Kruitschnitt's support, dieselization on SP stalled with his retirement in 1924. Garmany asserts that Kruitschnitt's retirement (and death soon afterward), left SP's progress toward diesel power "in the hands of men inculcated with generations of steam propulsion."[76] Steam did continue to dominate Southern Pacific's mindset, but SP was not alone in its reluctance to give up steam power. As historian Mark Mapes points out in his recent dissertation, the Pennsylvania Railroad had a lone voice, James Symes, calling for dieselization. But this factor alone would not explain the slow adoption of diesel. The Depression hit the railroads and their suppliers as hard as it had other industries, bringing expansion and modernization to a standstill. And railroads could only dieselize if the proper equipment was available. Even though some railroads, including SP, began to run diesel-powered passenger trains and yard

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74 Garmany, 60 and 73. The reasons Kruitschnitt outlined are fairly typical of discussions about the pros and cons of diesels that would take place over the next few decades. Other railroads, particularly those in the North and East, would also express allegiances to the coal industry. For a discussion of these debates, see Mark G. Mapes, "Losing Steam: The Decision-Making Process in the Dieselization of the Pennsylvania Railroad," Ph.D. dissertation, University of Delaware, 2000, 181-271. On the pros and cons of diesel engines, see Mapes, 36-44.

75 Mapes, 71.

switchers during the 1930s, it would be the 1940s before freight diesels were available. The Electro-Motive Corporation, a young firm that had begun by building motorcars and progressed into diesel locomotives, had entered the market, but the established locomotive builders, Baldwin, Alco, and Lima, were reluctant to turn away from steam. Additionally, during World War II, the War Production Board restricted production to established models and determined which roads would get them. This limited availability of diesels during the war made it impossible for some roads, including SP, to move forward with dieselization (other than some additional yard switchers) until after 1945.[77]

The transition to diesel power required more than the change of locomotives. Rather it necessitated a whole host of organizational and technological changes.[78] The companies involved carefully considered the change from steam to diesel, itemizing the costs of transition, the concomitant change in fuel

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[76] Garmany, 60.

[77] Mapes, 12, 310. Albert Churella discusses Alco's reluctance to give up its steam-era corporate culture in Albert Churella, "Corporate Culture and Marketing in the American Railway Locomotive Industry: American Locomotive and Electro-Motive respond to dieselization," *Business History Review* 69 (Summer 1995): 191-229.

[78] Few scholars have investigated the modifications in supporting facilities and activities that were required to support new diesel locomotives, focusing instead on the decision-making process involved in adopting a new technology. Economist Robert Bingham does discuss GM's provision for engine servicing and rebuilding in his arguments regarding EMD's rise to prominence in the diesel locomotive industry. Bingham coincidentally finished his work at an important turning point in locomotive maintenance history, so he was unable to cover the railroaders' transition from steam to diesel maintenance. See Robert Charles Bingham, "The Diesel Locomotive" A Study in Innovation," Ph.D. dissertation, Northwestern University, 1962.

price, and even negative externalities such as the transition's influence on the coal industry.[79] Nonetheless, it is not clear that any railroad company fully appreciated the massive changes in maintenance operations that dieselization involved. It seems, instead, that there was a significant learning curve involved, as is made clear in an examination of the Sacramento Shops. In a June 1949 paper, SP's superintendent of motive power F. E. Russell explained that, while existing steam facilities could be used for heavy repair, "some" re-arrangement of facilities was necessary. Here Russell glossed over a transition that would challenge SP through the next ten to fifteen years. [80]

It was in 1947 that SP first started analyzing how long it would take to fully dieselize and the most efficient approach to the process.[81] Indeed, Southern Pacific appears to have followed the path of dieselization delineated by Mapes. Like Pennsylvania and others, SP moved through "situational adoption," introducing diesels in isolated assignments; "general conversion," in which

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[79] Regarding the impact of power transition on the coal industry, see "Monongahela Railway Company Shops," HAER PA-218, and Mapes.

[80] F. E. Russell, "Railroad Motive Power Maintenance Facilities as Influenced by Change from Steam to Diesel," June 14, 1949, manuscript, CSRM.

[81] It is difficult to compare exactly when railroads formally committed their companies to full dieselization, since the decisions pre-date actual locomotive purchases, and companies' long-range plans are not necessarily rendered clear simply from rolling stock statistics. Board of Director meeting minutes would likely reveal more about the SP's decisions regarding the diesel transition, but these records (held at Stanford Library Special Collections) remain closed at this time. On SP's plans to fully dieselize, and references to earlier reports on the subject, see Southern Pacific Company, "Ten Year Motive Power Survey," August 15, 1948, CSRM.

the diesel was introduced into all facets of service, but was not intended to fully replace steam; and concluded with "total transition" of its fleet.

SP's dieselization story began when the road joined with the Chicago and North Western and Union Pacific railroads to operate diesels on a new, streamlined passenger train, the *City of San Francisco*, in 1936. Three years later, the company acquired ten diesel switchers and, by 1941, had plans to purchase forty more diesel switchers.[82] SP's dieselization plans then took a back seat to the exigencies of World War II. Thanks, at least in part, to limitations imposed by the War Production Board, the company purchased no road freight diesels until peace returned, making SP one of the later railroads to adopt the new technology.[83] By the mid-1950s, though, it was clear that the company had committed itself to total dieselization.

Railroads could only move as fast as the available technology, and diesel technology evolved in fits and starts. The traditional steam builders, Baldwin, Alco, and Lima, only reluctantly began manufacturing diesels before the war. It would be a young company named Electro-Motive Corporation that initially invested in the research and development needed to make

82 SP Annual Report, 1939. SP Annual Report, 1940, 24.

83 SP subsidiary St. Louis-Southwestern, commonly known as the Cotton Belt, did receive five 4-unit sets of EMD FT freight diesels in 1944, giving the parent company access to valuable information on freight diesel performance and maintenance requirements.

diesel-electric propulsion practical. Electro-Motive was purchased by General Motors, a company even better situated to fund the development necessary, in 1930. Passenger locomotives were glamorous, but it was freight hauling that posed the biggest hurdles—along with the greatest rewards—and the Electro-Motive Division of General Motors (EMD) would lead the pack in both passenger and freight diesel locomotive development.[84]

It is important to note that General Motors planned a narrow EMD product line from the start, opting to utilize its expertise in mass production to bring down the cost of diesel technology. This stood in stark contrast to steam locomotive practice, where a seemingly endless variety of locomotives had come into the market for various reasons. Locomotive variety drove up costs, as it required workers who were capable of maintaining a diverse fleet of locomotives by making and fitting a large array of custom parts. Ultimately, the standardization of the diesel line would assist railroaders in introducing a more efficient materials flow and repair process into their shops.[85]

SP attacked competition from other passenger carriers, such as automobiles, airlines, and busses, by coupling diesel efficiency with modern, streamlined service on its Pacific Coast

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[84] Mapes, 44-46, 69. Brown, 23. Electro-Motive became a division of General Motors in 1941. Sold by GM in 2005, the company is now known as Electro-Motive Diesel.

[85] Brown, 231-32.

and transcontinental routes.[86] In 1945, the company revealed plans to expand the passenger program (albeit slowly) by announcing its intention to add a pair of diesel-powered, streamlined *Shasta Daylights* to the San Francisco-Portland run. By 1946, the company had already expanded the order to five 6,000-horsepower passenger diesels and twenty 6,000-horsepower freight diesels.[87] Additional diesel locomotives were acquired in 1946 to re-equip the *City of San Francisco* streamliner.[88]

SP flirted with the cutting edge of passenger diesel development before World War II, but the company chose to stick with the steam technology it knew to pull the vast majority of its passenger and freight trains until after the war. It was the Santa Fe instead that led the switch to freight diesels in the West, placing orders for twenty sets of EMD's FT units by 1941. By the end of 1946, when SP was just entering the freight diesel business,[89] thirty railroad companies already had 1,275 freight diesels in service or on order.[90]

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[86] SP Annual Report, 1950, 5. Mapes, 80-81.
[87] SP Annual Report, 1945, 3. SP Annual Report, 1946, 25, 27. "Diesels," as used in these annual reports, actually referred to three- or four-unit sets of 2,000- or 1,500-horsepower locomotives. Though SP may have originally intended to operate them together, the various units were soon intermingled. For a time, three-unit passenger consists and four-unit freight consists were the norm, but the railroad came to realize that the number of units could easily be altered to suit any particular train. This flexibility was a major advantage of diesels over steam.

[88] SP Annual Report , 1937.

[89] SP Annual Report, 1946. SP generated reports forecasting and planning for rolling stock needs beginning in the 1940s. These reports, referred to in other publications, were not located. Titles include, "Five Year Motive Power Survey," August 1, 1947; "Branch Line & Local Service Survey," November 22,

Maintaining the New Technology

As they acquired diesel locomotives in ever-greater numbers, railroad companies had to start thinking about how their locomotive maintenance practices needed to change to suit the new power. Although the maintenance procedures for diesels were very different than those for steam engines, the railroads, with a century of experience under their belts, tended to think in steam terms. In 1946, for example, discussions in the Mechanical

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1947; and "Advance Report—Ten Year Motive Power Survey," April 6, 1948. These reports are cited in Southern Pacific's "Ten Year Motive Power Survey," August 15, 1948. If the opening of the Panama Canal lent the steam shipping industry a competitive edge at the turn of the century, it was truck shipping and its lack of Federal regulatory legislation that forced railroads to cut costs and expand their promotional efforts at mid-20th century. Railroad lobbyists pushed the Federal government for trucking regulation, as railroads had suffered Interstate Commerce Commission regulation for decades and contended that the lack of regulation gave trucking an advantage in the marketplace. SP's president reported optimistically to shareholders that, "relying upon America's sense of fair play to give each form of transportation an equal opportunity to succeed . . . the railroad industry looks ahead with confidence." SP Annual Report, 1950, The President's letter, 1. Despite railroaders' confidence, truck hauling increased five fold in the 1930s, so that by the end of the decade the industry carried 10 percent of the country's freight. Mapes, 80. SP, like other railroads, approached dieselization by individual district. Yet even in the late 1940s, the company lacked sufficient numbers of locomotives to completely dieselize any single district. As such, the company concluded, future purchasing would be done with the goal of assigning new diesels to districts where the greatest savings could be realized. Using this approach, then, Gerber-Bakersfield, Roseville-Oakland, and San Francisco-Watsonville, the commuter trains, and some other branch lines, would be the last to be dieselized. These reports are cited in Southern Pacific, "Ten Year Motive Power Survey," August 15, 1948, 6.

[90] As Mark Mapes points out, it is unclear the extent to which the War Production Board influenced the entrance of certain companies into this market. See Mapes, 120. But Mapes, in discussing arguments at the PRR favoring diesels, notes that the local atmosphere in which the PRR operated may have had significant influence on why particular proponents of diesels pressed for early dieselization. Chicago, the home of Electro-Motive, also held the headquarters for both the Burlington and the Santa Fe, "both of which were in the vanguard of dieselization." The Southern Pacific, headquartered far to the West in San Francisco, did not benefit from this pro-diesel milieu. See Mapes, 311.

Division of the American Association of Railroads and the Locomotive Maintenance Officers' Association included the pros and cons of scheduling classified repairs in the manner they had used on steam power, many arguing strongly against installing what they considered to be a cumbersome system.[91] To those who were running a good number of diesels, the new maintenance needs of the units were not simply projected, but a reality.

Planning for the needs of a fully dieselized railroad was difficult enough, but railroads had perhaps a more complex issue in planning the *transition* from steam to diesel. Diesel locomotives differed substantially from steam locomotives and, at least initially, repair facilities had to support both types of power. SP, having decided to gradually change all of its motive power from steam to diesel, developed both short- and long-term plans to modify its facilities for diesel maintenance.

SP management studied the heavy maintenance and running repair practices of other railroads as they plotted the course for dieselization. Subsidiaries Northwestern Pacific and San Diego and Arizona Eastern Railway Company served as models, and managers surveyed "to what extent existing facilities, machinery and tools will not be necessary after substitution of Diesel locomotives for steam locomotives, and changes in or replacement

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[91] Mapes 134-136.

facilities required."[92] The surveyors assessed the costs of changes or replacement of the steam locomotive repair shop, engine house, turning and servicing facilities, machinery and tools; the costs of installing a diesel locomotive repair shop, engine house, fueling and servicing facilities, and machinery and tools; and the cost to abandon fuel and water stations not required for diesel operation.[93]

SP revamped running repair and turning facilities first. Indeed, service facilities saw dramatic change well before heavy repair shops. The loss of roundhouses would be the most publicly visible change marking the rising diesel era as railroaders introduced new designs into running repair and service facilities. Multiple-unit diesel locomotives were simply too long for roundhouses and turntables. As F. E. Russell pointed out, the typical four-unit diesel freight locomotive measured about 200 feet in length, while the largest SP steam locomotive hit only 125 feet, including tender. Since most multi-unit freight diesels had a cab unit at each end and operated equally well in either direction, they rarely needed to be turned around like steam locomotives, making turntables largely unnecessary. For these huge diesels, rectangular structures were preferable

[92] These reports are cited in Southern Pacific, "Ten Year Motive Power Survey" August 15, 1948, Exhibit 7.
[93] *Ibid*. The Reading Company abandoned its Wilmington, Delaware, repair shop after replacing all of its steam locomotives with diesels. See "Wilmington and Northern Repair Shop," HAER DE-13, 5.

over roundhouses, with tracks running longitudinally with pits to facilitate truck work and brake inspections, and elevated platforms for easy access to internal components. SP built its first diesel service center in this design at Taylor Yards, L.A.[94]

Whereas complete diesel service facilities were added to some districts, Sacramento's heavy repair shops were forced to wedge heavy diesel repairs into buildings and lots designed for steam technology as the company worked through its transition to new diesel power. By the late 1940s, a portion of the Sacramento Shops had been designated for heavy diesel maintenance, and for the next ten years the addition of diesel maintenance complicated

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[94] Russell, 3. SP's first two orders for freight diesels were slated for service from Los Angeles, thus, that area was the logical choice for the company's first diesel service facility. In 1947, SP laid out its plans for a modern engine house in Los Angeles' Taylor Yard (275 ft. by 141 ft., complete with six 215-ft. concrete inspection pits). SP Annual Report, 1948, 22. The $1.1 million project took two years to complete. Designed in the longitudinal style Russell preferred, each pit could handle the largest of the new four-unit, 6000-h.p. diesels, and servicemen used the three-level shop design to inspect and repair the locomotives. "New Diesel Shops," *SP Bulletin* (Sept-Oct 1949): 7-9. F. E. Russell, "Railroad Motive Power Maintenance Facilities as Influenced by Change from Steam to Diesel," June 14, 1949, manuscript, CSRM, 5-9. Diesel servicing facilities continued to follow diesel road service as routes expanded beyond Los Angeles. By the late 1940s, SP was planning for freight service between Ogden, Utah, and Sparks, Nevada, and between Roseville, California, and Eugene, Oregon. Maintenance facilities followed at Ogden and Roseville, with the latter project started in 1949.

[94] SP intended Roseville as the largest diesel servicing facility when it broke ground, projecting that it would have 70 of its 6000-h.p. diesels operating in Northern California, Oregon, Nevada, and Utah by the end of 1950, with long-term plans to have the Roseville facility service diesels between Portland and Bakersfield as well as between Oakland and Ogden. The site's first installation to inspect, service, and repair diesels was up and running in 1950. Other stations quickly followed. A three-track running repair facility was completed in San Antonio that same year, and a diesel service station was installed in Eugene by 1951. SP Annual Reports, 1950, 13. "Diesel Service Station," *SP Bulletin* (May 1951): 3.

an already busy, complex operation. Unlike steam locomotives that had to be repaired as a whole, diesels could have failed components replaced with identical spares. For example, a diesel locomotive needing major engine repair could have its engine removed and replaced with another engine instead of sitting in the shop while the original engine was rebuilt. The original engine could then be disassembled, overhauled—often by the manufacturer at its factory—and installed in another locomotive when needed. The same process worked equally well for main generators, traction motors, and most other components. In many cases, repair involved only the exchange of some cylinder assemblies or heads instead of an entire engine, and these components could be rebuilt and reused in another engine. Diesel maintenance also required some new tooling and equipment in the shops. Special facilities added to support diesel maintenance included portable scaffolding for working on engines when they were on the floor; piston racks that held eight pistons each; wooden, linoleum-topped benches for working on sub-assemblies; universal positioners with adaptors to accommodate different cylinder heads; a cleaning tank for removal of carbon from steel heads, connecting rods, and the like; a smaller cleaning tank for aluminum pistons and other parts; a 10,000 gallon storage tank and pump for treated cooling water; a primer pump to circulate oil throughout the entire lubricating system; an exhaust pipe on the test run pit for removal of gases from the shop; and electrical equipment for testing the output of generators.[95]

As diesel technology spread through the system, and as the new units aged and demanded more substantial work, more and more shop space was consumed by diesel maintenance. Diesel repair areas grew gradually within the Sacramento Shops through the 1940s and 1950s, using more and more space previously allocated to steam locomotive repair. The company's purchasing records detail the piecemeal approach the company initially took to the transition between the two technologies. A July 1955 request to have tracks and floors reworked to support diesel repair was first denied, B. M. Brown contended that "We are still doing a substantial amount of steam locomotive work at Sacramento General Shops and recommend that this project be deferred until complete dieselization has occurred."[96]

F. E. Malloy responded,

> It is true, as stated by Mr. Brown that we are presently engaged in considerable steam locomotive repair work. This work however is performed in the central and southern portions of the structure and it can safely be said that the northern portion of the shop will never again be used for steam locomotive repairs, in as much as this area is equipped for diesel work and we, of course, are continually engaged in diesel maintenance. Additional area is urgently needed in the extreme north end in order to properly and

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95 F. E. Russell, "Railroad Motive Power Maintenance Facilities as Influenced by Change from Steam to Diesel," June 14, 1949, manuscript, CSRM, 11.

96 B. M. Brown to F. E. Malloy, July 28, 1955, GMO SAC 15201, CSRM. It is unclear what position B. M. Brown held at SP.

> efficiently carry on diesel engine stripping, sub-assembly stripping, cleaning and buffing of diesel parts, etc.[97]

The need for space was acute, and by the end of the year more changes were requested. In December 1955, Sacramento management requested authority to remove 120 feet of trackage formerly used to temporarily store driving wheels and to renew the associated concrete floor. The requestor explained that "Diesel locomotive sub-assembly and component repairs at Sacramento Shops has now grown to the extent in the main Machine Shop that all the area lying north of track #10 is now used for diesel parts reconditioning."[98]

SP reconfigured the Sacramento Shops arrangement constantly as it wrestled with how to accommodate two very different power technologies while simultaneously working out an efficient approach to maintaining the new diesels. Diesel repair activities increasingly took over space formerly assigned to steam maintenance, though space clearly was a contentious issue not easily resolved between managers. What is more, the purchase of locomotives from different manufacturers further complicated the works. Where maintenance practices differed little for steam locomotives built by different builders, the parts and procedures for Alco diesels were not the same as those for EMD products, and SP owned some of each. The engines alone differed enough to

[97] F. E. Malloy to R. A. Miller, August 11, 1955, GMO SAC 15201, CSRM.

[98] GMO 64813, December 5, 1955, CSRM.

warrant separate repair areas. In 1952 management had allocated the northernmost four bays in the Erecting Shop (out of 25) to diesel maintenance. A sub-assembly repair bay consumed the northeast corner, and a diesel engine erection area was added to the center section. But by 1953 this arrangement was subsumed in a new configuration that filled seven bays and 200 feet of the center and eastern portions of the north end of the building. These sections were divided between EMD and Alco reconditioning. To Bay 8 was added a "diesel engine transfer track" that connected to a transfer dolly and track running north to south in the central portion of the building.[99] But space and engine variation were not the only issues. Also at issue was the very method of diesel maintenance.

Sacramento operated its combination diesel and steam maintenance facilities in this manner until the end of the decade.[100] Steam locomotives continued to receive their

[99] "Proposed Machinery Layout: Locomotive Machine Shop," NDS 614, July 13, 1951, updated June 30, 1951, CSRM. "Diesel Locomotive and Loco. Machine Shops," NDS 614, July 13, 1951, updated October 21, 1955, CSRM. The 1959 president's letter to stockholders suggests a greater concern with upgrading facilities and equipment, including comments that "to improve operating efficiency and keep pace with the growth of the West and Southwest, an additional $74 million was invested in 1959 in capital improvements, including more Centralized Traffic Control, additional diesel locomotives and specialized freight cars, new expanded piggy-back facilities, . . . modern maintenance and yard facilities," and "In order to achieve greater efficiency, waste of all kinds must be eliminated." SP Annual Report, 1959, President's Letter, 1.

[100] The description of the shop layout and work as it was transformed into a diesel repair shop was developed from interviews with the following former workers: Frank Stengele, July 27, 2001; Richard Juarez, June 7, 2001 and July 20, 2001; Al Freitas, Jr., October 14, 1996 and July 19, 2001; Mac Gaddis, August 1, 2001; William O. Brown, November 21, 1996; Richard Himenes, June 7,

scheduled repairs in much the same way they had throughout the first part of the twentieth century, though in less space. At the same time, workers and managers jammed diesel repairs in the northern third of the Erecting and Machine shops and doctored the new units to the best of their ability.[101]

Management, engineers, and workers alike knew the shops were bogged down by waste and inefficiency imposed at least in part by a 40-year-old maintenance facility arrangement designed for steam-era needs. As was the case in many companies, it took strong proponents within the organization to force radical change. Two people in particular helped press the issues of rational materials flow, quality control, and repair standardization. R. J. Russell, Chairman of the SP Board of Directors, recognized that the company was losing money to inefficient operations, much as it had before E. H. Harriman took over the company at the turn of the century. In the late 1950s, Russell requested that each department appoint one person to study their department and recommend changes; that person would report to the Vice President of Operations. At the same time, mechanical engineer Frank Stengele pushed his superiors toward re-designing SP's repair facilities and operations. Stengele's appointment to a newly created position, engineer of planning and

2001; Daniel Derich, July 28, 2001; Cecil Bingaman, n.d.; and Carl Blakkolb, n.d., CSRM.

production, suggested a change in mentality for SP management. By 1960, when departments apparently failed to produce enough savings, SP's leadership made a critical decision. The company decided to hire outside consultants to assist in reworking the company's maintenance facilities.[102]

Emerson Consultants recommended the creation of various departments now considered common to large operations, such as quality control, budget, and industrial engineering. Frank Stengele, who had been pushing for such radical change, was charged with controlling systems management for all of the SP in his new position as head of Industrial Engineering for the entire system. Two draftsmen made up his staff. The new office was headquartered in San Francisco, though many of their projects would focus on the Sacramento Shops.[103]

While Emerson made recommendations about larger system organization, it fell to SP engineers and management to design new maintenance departments and then make them work. Stengele toured other railroad shops to get up to speed on "best practice," but other railroads were little better off than SP. The company's engineers were, however, familiar with EMD's plant at LaGrange, Illinois. The manufacturer had been rebuilding its

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[101] Al Freitas, Jr., described various diesel repair processes prior to the process redesign in 1960. See Al Freitas, Jr. interview, CSRM.

[102] Frank Stengele interview, CSRM.

[103] Frank Stengele interview, CSRM. For discussion of Emerson and facility transition see William O. Brown interview, CSRM.

diesel engines since the 1940s as a service to its customers. Not surprisingly, EMD, as a division of one of America's largest automobile manufacturers, was steeped in assembly line production methods. It employed the jigs, fixtures, heavy equipment, and specialized labor common to assembly-line mass production in its "production-line rebuilding" arrangement. Diesel engines were disassembled and rebuilt station-by-station, drawing from a variety of sub-assembly areas. This would be the system SP would emulate.[104] In fact, the standardized process was not all that foreign to the company. Repair standards and procedures for many steam components had been in use on SP since first established by H. J. Small in the 1890s.

On Emerson's recommendation, Stengele and other corporate management met with supervisors and foremen throughout the system, discussing plans for reworking the individual shops and requesting input. Stengele and management alike were well aware that they were asking for dramatic changes from the workers. Many of SP's craftsmen had spent their adult lives as boilermakers, machinists, or blacksmiths for the company. Indeed, many were carrying on something of a family tradition of railroad work.

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[104] EMD opened facilities throughout the U. S. as its business expanded, though its principal rebuilding unit remained at LaGrange. Most railroads sent their diesel engines to LaGrange for rebuilding, though by 1951, the company had opened several job shops to handle smaller electrical repairs, as well as larger rebuilding lines at St. Louis, Baltimore, and Los Angeles. EMD performed such rebuilds on a unit-exchange or repair-and-return basis. Cecil Bingham contends that such servicing may have helped EMD dominate the locomotive market. Cecil Bingham interview, CSRM. EMD's engineers went so far as to review Sacramento's new diesel repair facility design.

They had learned their trades in the same way trades had been handed down for centuries, through a formal apprenticeship process, a structure later defined and protected by union regulations. Diesel technology would require an entirely new education for many workers. Electricians were particularly challenged. Used to the simple lighting circuits of steam locomotives, they had to quickly learn how to diagnose and repair the complex electrical transmission and control systems used in diesels. But in the process, their status in the shop labor hierarchy rose from that of a secondary craft to one befitting a predominant one. Conversely, boilermakers found their work—and status—evaporating with the demise of steam. For those like machinists, the amount of work to be done remained much the same, but the nature of it changed drastically. Instead of individually machining and fitting parts, they now spent most of their time changing out purchased, interchangeable components and assemblies. The company brought craftsmen system-wide to Sacramento for a week of discussions and presentations regarding new processes and how the new Industrial Engineering department would work with the different shops to effect the necessary changes.[105]

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[105] Frank Stengele interview, CSRM. Regarding retraining, William O. Brown commented that "we had to retrain almost everybody, everybody in the shop almost . . . They had to learn a new trade almost. They had to learn the maintenance of the diesel engine." William O. Brown interview, CSRM. Also see Cecil Bingham interview, CSRM. Sociologist W. F. Cottrell examines the social and economic ramifications of the switch to diesel technology on Caliente, a railroad town, in "Death by Dieselization: A Case Study in the

To a viewer not privy to the decades-plus transition to diesel technology, the final, full transition to diesel power appeared swift and dramatic. In 1959, less than a year after SP's last official steam run, the company began pulling down the Roundhouse to make room for new diesel support facilities, including a new Engine Parts Cleaning Building. It was equipped with a 25-ton bridge crane, 12 jib cranes, engine disassembly facilities, and a variety of cleaning machines that would handle all the parts of a diesel engine. Within the Erecting Shop, engineers installed a new 15-ton bridge crane in the west bay and an engine reassembly line in the center bay running north to south. North of the Truck Shop (formerly the Boiler Shop), they erected a load-test shed, where locomotives were tested after final assembly.[106]

The result of the 1960s revamp was a main disassembly/ assembly area supported by a series of sub-assembly lines. After inspection, locomotives slated for diesel maintenance entered the Erecting Shop at the north end for stripping. The locomotive's trucks were removed to the truck cleaning area and then serviced in the Truck Shop.[107] The diesel engine and generator were

Reaction to Technological Change," *American Sociological Review* 16 (June 1951): 358-65.

106 GMO 79148, "Proposed Locomotive Shop Facilities," September 20, 1960, CSRM. Frank Stengele interview, CSRM.

107 With the transition to diesel power through the 1950s, a shop to maintain boilers and cabs became increasingly less necessary. In the early 1950s, the north end of the building had been modified to accommodate diesel locomotive painting and diesel truck repairs. By the end of the decade, the entire

removed from the locomotive by an overhead crane, separated, and the engine moved to the cleaning building. There the entire engine started through a U-shaped progression around the building, starting with an initial cleaning. Workers then started the process of disassembly, dropping pistons, rods, and cylinder sleeves into 4-foot iron bins that then moved through a tunnel for blast cleaning. After further disassembly, parts bins were loaded into a multi-stage, automatic cleaning machine that extended the length of the building (though some parts were cleaned in machines located outside the building). This larger unit included pre-cleaning, cleaning, draining, rinsing, an application of rust preventive, and draining. The machine could hold two tons of parts at a time. Cleaned parts were either moved to subassembly shops for repair or re-assembly, or returned to bays within the Erecting Shop, adjacent to the relevant work areas. Engine blocks ready for re-assembly were brought in the north entrance of the Erecting Shop. The engine was re-assembled at stations throughout the center bay of the building, the shop crane moving the engine from station to station. In the meantime, major electrical components, such as the main generator and traction motors underwent their own cleaning and repair processes, as did mechanical components like the air compressor and radiators. The finished components were then returned to the

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Boiler Shop building had been reworked into a truck maintenance facility, though it maintained some space for metal fabrication. "Floor Plan of Boiler locomotive and re-installed. The locomotive then moved to the load test shed for testing before being painted and put back into service.[108]

Industrial engineers designed and installed various jigs and fixtures throughout the shops to make heavy work easier, faster, safer, and more uniform. Whereas machinists formerly had to work under the diesel engine to install a crankshaft, for example, a specially designed crane allowed the block to be turned over so the crankshaft could be lowered in from above. Stations were arranged so that the workspace was at a comfortable height and parts were within arms reach. Power tools made much of the assembly work easier and more consistent. In other areas, more sophisticated equipment was introduced, like ultrasonic cleaning machines.[109]

Arduous and time-consuming jobs, like truck cleaning, were completely redesigned. Formerly, two men armed with crowbars and hot water hoses scraped the accumulated grime off trucks. Engineers replaced this procedure with an approximately 30-foot

Shop," NDB 1315, April 21, 1954, CSRM.

[108] Interviews with Frank Stengele, William O. Brown, Richard Juarez, Al Freitas, Jr., Mac Gaddis, Richard Himenes, Daniel Derich, Cecil Bingaman, and Carl Blakkolb, CSRM. Regarding the transition to the new production line, Al Freitas, Jr., explained, "That's what went on for quite a few years until their engines started getting really bad and they had to pull out complete engines on them. Then they went into rebuilding. They got some guy from GE or General Motors. He made like a production line where you strip an engine right down to the block. Took everything apart and you took the whole locomotive apart. You had to repaint it and sandblast it and the whole damn bit." See Al Freitas, Jr., interview, CSRM.

tunnel lined with high-pressure (800 pounds per square inch) water nozzles. A winch moved the truck back and forth through the tunnel, and a sump collected the water and grime. After about 45 minutes, Stengele reported, "that truck was spotless."[110]

The conveyors, pneumatic tools, and ergonomically designed workstations of the 1960s Sacramento Shops stood in stark contrast to the shop arrangement of the 1890s, or even the 1940s. Whereas steam-era repair facilities relied on standard machine tools, grouped by type, the diesel-era repair facility was marked by the inclusion of custom-designed tools and cleaning units. Likewise, work moved through the shops in whole new ways. Diesel locomotives may still have been stripped in the Erecting Shop bays, but there the similarities ended. In the new era, the major components were taken to specific shops to be disassembled, cleaned, and overhauled in a standardized process, with each one moving through a preset succession of steps.

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[109] Interviews with Frank Stengele, Richard Juarez, Al Freitas, Jr., Mac Gaddis, Daniel Derich, Richard Himenes, Cecil Bingaman, and Carl Blakkolb, CSRM.

[110] Frank Stengele interview, CSRM.

PART II – CAR AND SUPPORTING SHOPS

PLANING MILL

The Planing Mill, the earliest of the remaining buildings, exhibits a space matched to its changing function. Referred to as the "woodworking and car manufactory" in the *Mining and Scientific Press*, the "two colossal stories" provided space for production lines capable of output varying from the "common truck to the most luxurious car."[111] Built beginning in 1867, and in use by 1869, the brick building measured 231 feet by 90 feet with an additional small wing.[112] The builders relied on local materials, consisting of mainly brick, wood, and rubble. With limited access to iron, the CP saved all bits of iron for the construction of engines, cars, and machinery. Built on a pier foundation of brick and stone rubble, the building's primary orientation was in the east-west direction.[113] Load-bearing brick pilasters provide support for the walls with American

[111] "The Pacific Railroad Terminal Shops at Sacramento," 72.

[112] The evolution of the small wing is discussed in the section titled Car Shop No. 3. Various sources sometimes have conflicting information in dates and measurements. A periodical may claim one measurement, whereas another plan indicates another measurement. The source will be noted accordingly. Some error may be from differences in interior vs. exterior measurements as well as other sources of miscommunication. The measurements stated correspond to contemporary sources and compare with current architectural evidence.

[113] *Valuation,* II, 395-406.

round-arched corbelled windows. The building stands nineteen bays in length by eight bays in width. The wood trusses, spaced 13.5 feet apart and in line with the pilasters, support the iron roof and monitor above. Roof monitors extend almost the entire building length, ending one full bay short, a construction common to many mills at this time. Windows line the length and width of the monitors, alternating with siding.[114] A water tower was located on the western end of the roof.[115]

The 1867 building design followed a functional order that relied upon repetition to reduce design and construction costs and ease maintenance and repair. Though a definite repetition existed in the facade of windows and doors, each building side varied according to its purpose. Windows dominated the exterior walls of the Planing Mill, though the east side featured large doors that allowed cars to enter and exit on the ground floor. Eight bays in width, the eastern side was built with double pilasters to provide spans wide enough to include four doors. Small windows within the double pilasters maximized light infiltration. The upper floors had large arched windows between the double pilasters.

The construction was tailored to the size and weight of rail cars and woodworking machinery. The brick-and-rubble foundation

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[114] Bradley, 181 and 189.

[115] Photograph of Planing Mill and Car Shop No. 3 between the years 1873 and 1888. Neg. No. SPX12-4, SPX 183, n.d., CSRM.

provided a stable floor, and additional reinforcement maximized floor load capacity in areas with track in the floor. Heavy machinery, including large saws and planers, operated on the ground floor.[116]

While the first floor could withstand heavy loads and machinery, the second floor was designed for the lower floor loadings expected from a variety of supporting operations. The first evidence of these compartmentalized shops appeared in reports by 1877. The second story was divided into areas for the Upholstery Shop, Cabinet Shop, and Pattern Shop.[117] Subsequent floor plans arranged and rearranged workbenches, machinery, offices, and storage to optimize use of the limited space. Over the next decade, the second floor operations demanded more room. The shops continued to expand with completion of the Car Machine Shop—a slightly smaller yet equally impressive shop parallel to and north of the Planing Mill.[118] The Upholstery Shop moved into the second floor of this new building, allowing the Cabinet Shop to occupy the entire second floor. The expanded Cabinet Shop included a large gluing and veneering area, an "artistic and

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116 *Valuation*, II, 397. "The SP Company's Railroad Shops," *Sacramento County and its Resources*, Souvenir of the Bee, 1894, 116.

117 "Central Pacific Railway," *The Railway Age* (October 25, 1877): 1461.

118 For more information, see section titled Car Machine Shop.

costly" operation to produce elaborate interior finishes for passenger cars.[119]

The fire of November 7, 1898, destroyed the Planing Mill and Car Machine Shop, halting passenger and freight car operations. Originating in the Upholstery Shop (now the Car Machine Shop), flames quickly spread to the neighboring Planing Mill. When firefighters attempted to extinguish the fire, they faced several obstacles. Ironically, when the water tower on the Planing Mill roof collapsed, water fell all over the men, not on the burning building. (The water tower was not rebuilt.) Further, the city's fire hoses did not match the threading on the shops' fire hydrants. Mud-filled pipes further delayed action to arrest the flames. The resulting low water pressure prompted new measures to install adequate water mains and standardize connections with the city. Though fires were all too common, each incident renewed safety awareness and efforts to fix what went wrong.[120]

Immediately after the fire, the Planing Mill was completely rebuilt according to plans of similar layout. Having established a design that worked, and with the foundation and some brickwork still intact, the shops used the footprint and the standing walls to reconstruct the rest. As explained by the *Sacramento Bee*,

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119 "The SP Company's Railroad Shops," 116.

120 "Fierce Fire at the Shops: Important Departments Suffer From This Morning's Blaze," *Sacramento Bee* (November 7, 1898): 8. "Clearing Off The Debris: Busy Scenes on the Site of Monday's Fire," *Sacramento Bee* (November 8, 1898): 5.

> Superintendent H. J. Small said . . . that the buildings would be erected upon the same plans as those destroyed. Work will be commenced at once, and it is expected to have the buildings well along towards completion in sixty days' time . . . they will be stocked with the latest improved machinery, to take place of that lost in the fire and which had been in constant use for many years.[121]

The damaged buildings held operations essential to car construction, so the SP rebuilt them immediately while enforcing new precautions against fire. Changes were minor in the reconstructed structure, but they included truncated arches over the second-floor windows instead of the original full arches. The eastern wall, which formerly held seven windows on the second level, had only four, wider windows, and the small windows within the double pilaster were eliminated. These wider, truncated-arch windows furnished more light than the original windows, making the narrow windows within the double pilasters unnecessary.

Aside from the walls, improvements in roofing technology allowed a steel truss in place of the wood truss. The new roof held a clerestory similar to the previous structure, but with horizontally pivoted windows, a popular detail in the 1880s.[122] The new clerestory not only increased the window area, but the revised arrangement also furnished better ventilation, since the pivoted sash could be opened as needed. This particular design placed four sashes in each of the nineteen bays. Two were fixed,

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[121] "New Shops Will Go Up: Buildings to Be Nearly Finished in About Sixty Days," *Sacramento Bee* (November 10, 1898): 8.

[122] Bradley, 163.

and two were opened or closed using a hand-operated rope-and-pulley system to the floor below.[123] While the monitors were later enclosed with corrugated iron, the pulleys remain as evidence of their former function.

With a new shop of similar design, operations continued as before. Carpentry operations continued on the first floor until it became a machine shop after World War II. For the first half of the twentieth century, the Cabinet Shop kept its central location on the second floor of the Planing Mill. Flat belts to three north-south line shafts under the roof trusses drove the machinery. Two bridges extended from the middle bay, one north to the Car Machine Shop, and a second one south to the Privy. The central location of these access ways attempted to limit intrusion as workers walked through the second floor of the Planing Mill between Car Shop No. 3, the Car Machine Shop, and the Privy.[124]

Added during the reconstruction of the Planing Mill, the drop ceiling on the western 86 feet of the second floor shows a clear division in processes on the second floor. The Cabinet Shop benches lined the windows on the west half of the building, separated from the woodworking machinery in the eastern section by a partition. Where the veneering press, sash press, and

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[123] *Valuation*, II, 401.

[124] "Location of Machinery on Second Floor of Planing Mill: Sacramento Shops," 20 April 1900, Record ID No. 10047, CSRM.

cabinetry benches required cleanliness, the additional vertical space to the roof in the east end helped dissipate the noise and dust generated by the saws and planers, aided by the pivoting monitor sashes. Several photographs of the Planing Mill from the 1900s through the 1940s show the windows in the eastern half of the roof monitor in an open position.[125] Unfortunately, this was never truly adequate to handle the large volume of dust that these operations produced.

By 1914, compartmentalization and organization became more apparent in the Cabinet Shop. While the general layout of the western portion remained the same, an increasing number of machines triggered a need for better organization in the eastern end.[126] Planers, lathes, cut-off saws, ripsaws, drill presses, and jointers filled the floor space. As in other departments, office space offered the foreman some privacy from the machinery and commotion on the floor. Centrally located along the southern wall, the foreman maintained his presence across the floor. Between 1900 and 1914, the office was increased in area to meet the needs of the foreman. Cabinet operations continued through

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[125] See photograph looking northwest that shows the rebuilding of the northern Blacksmith Shop with wooden forms for the concrete. Eastern half of the Planing Mill had sash in pivoted position (Undated, but relative building evolution indicates it was taken ca. 1940). Neg. No. 7077c, CSRM Collection, n.d. See also photograph of north end of Blacksmith Shop with concrete walls, looking northeast. (Undated, but buildings present indicate ca. 1942). Neg. No. 7060c, n.d., CSRM.

[126] "Floor plan of Cabinet Shop for Cleaning Contract: Second Floor Planing Mill," April 10, 1914, Record ID No. 16324, CSRM.

the first half of the twentieth century until the poor ventilation finally forced operations to a new location.[127]

The old building lacked ventilation systems suitable for processes that produced fine dust particles, and installing such equipment was not practical. A long series of union grievances over the poor working conditions finally prompted management to move the Cabinet Shop from the Planing Mill to the newer facilities offered by the Saw Mill in 1944. The Saw Mill (ca. 1924) already had a powered exhaust system with sufficient capacity to handle the Cabinet Shop's needs.[128]

Aside from workers health and efficiency, space was a scarce commodity in the central location of the Planing Mill. Consequentially, many departments moved to newer and more adequate spaces. The Pattern Shop moved from the southern annex of Car Shop No. 3 and a machine shop replaced the Planing Mill on the first floor.[129] Once again, the Upholstery Shop moved back

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[127] "Location of Machinery on Second Floor of Planing Mill: Sacramento Shops."

[128] The Brotherhood of Railway Carmen had issued grievances about the poor working conditions in the Cabinet Shop since 1937, claiming that the fine saw dust threatened the well being of the workers. Finally, in 1944, the superintendent wrote the GMO asking his approval of this move. H. C. Venter, "Move Cabinet Shop at Sacramento General Shops from Present Location to Saw Mill," GM No. 26806, Sac-12525, January 12, 1944.

[129] The move would, "release valuable floor space for much needed expansion of the other adjacent departments, as this particular portion of the shops is very congested." It would also, "eliminate a very serious fire and dust explosion hazard from a congested shop area of high valued machine shops, car repair shops . . . and from closely associated hazardous operations such as upholstery shop, plating, battery electric shop, etc." *Ibid.* Also "Repaint Trusses and Interior of Roof, Upholstery and Pattern Shops," GM No. 32780, Sac-12945, October 24, 1945.

to the location on the second floor of the Planing Mill where it had been located sixty years prior. It now consisted of,

> an average of 20 employees making and repairing seat cushions, furniture, curtains, draperies, mattresses, pillows, etc. for Passenger Cars on the Northern District, and also various other upholstering and protective clothing work for Freight Car, Locomotive, and Store Departments.[130]

A 1945 photograph of the Upholstery Shop shows workers in this new location. Looking south towards the door to Car Shop No. 3, the view shows how the space was open to the truss and roof above. In 1951, however, a drop ceiling was installed in the eastern half of the second floor. No longer holding the large machinery of the Cabinet Shop, the open space was not necessary. Moreover, the temperature in the Upholstery Shop was nine to fifteen degrees higher than the neighboring Pattern Shop. The ceiling installation reduced the discomfort to employees as well as maintenance costs to the company. The two different ceiling styles—one from the 1898 construction, and the other from the 1951 construction—are silent reminders of how the building's functions changed over the years.[131]

One of the earliest structures in service at Sacramento, the Planing Mill continued to house a variety of operations until shortly before the shops closed. In 1955, the first floor of the

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130 "Repair Roof of Car Machine Shop Building and Install Ceiling over a Portion of the Upholstery Shop on the Top Floor of the Building," GM No. 48133, Sac-14202, March 15, 1951.

131 See "Upholstery Shop: Twenty-five with No Accidents," CSRM, 1945. "Repair Roof of Car Machine Shop Building and Install Ceiling over a Portion of the Upholstery Shop on the Top Floor of the Building," GM No. 48133.

Planing Mill held the Tool Room and Brass Room.[132] After 1985, the Sacramento Locomotive Works used the first floor as Locomotive Wheel Shop No. 1 (Roller Bearing Shop), while there was a machine shop on the second floor.[133] The Planing Mill's continuous and varied operations exhibit the protective and adaptive qualities of its structure. Barely distinguishable from the newer construction, the oldest walls still stand as evidence of its first construction and its durability.

CAR SHOP NUMBER 3

Beginning as an extension of the Planing Mill, Car Shop No. 3 also saw dramatic changes in its function during its life. In its early years, the shop primarily constructed, refurbished, and maintained passenger cars. SP halted new construction after the depression, but refurbishing work continued into the 1950s. As diesel locomotive operations increased in the 1940s and 1950s, the company utilized more and more of this space for diesel locomotive component repair and rebuilding. Because of its size and location close to the Erecting/Machine Shop, Car Shop No. 3 was ideally situated to handle small- to medium-sized components.

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132 GM No. 64360.

133 "Sacramento Locomotive Works," CSRM collection, ca. 1985.

While a building like the Roundhouse could not readily adapt to the new demands of diesel, Car Shop No. 3 offered readily convertible space.

The original, 1869 structure was a 45-by-90-foot ell attached to the southeast corner of the Planing Mill. Not yet known as Car Shop No. 3, it only stood two bays in length, and it shared its eastern facade with the Planing Mill. The southern wall was a temporary wooden wall to allow for easy extension southward when it became necessary. The original ell temporarily housed the Upholstery Shop on the first floor, while the second floor housed offices. In 1869, Superintendent Ben Welsh, who made "doors, windows, and upholstery from California material, that the CP railroad can require or use up, and at a cost quite as low as that of the same articles imported," led operations on the first floor. The second floor provided office space for the master mechanic, master car builder, the superintendent of motive power and machinery, the draftsman, and various clerks.[134]

CP's rapidly growing car fleet necessitated a car shop, so the company built an 11-bay, 300-foot-long extension to the ell in 1872. Historic photographs expose a difference in roof color that separates the older two bays from the otherwise identically appearing extension.[135] The earliest two bays, however, held two

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134 "The Pacific Railroad Terminal Shops at Sacramento," 72.

135 See photograph of the eastern elevation of the Planing Mill and Car Shop No. 3 (taken between 1873 and 1888). Neg. No. SAMCC 72-212-1439, CSRM, n.d.

stories, while the extension was strictly a single-story shop. Like the Planing Mill, the northern portion was built upon a rubble and brick pier foundation, but the southern extension was built on a brick and redwood grillage. The eastern wall had 12-foot-wide bays on 22-foot centers. The middle brick section continued the double-pilaster design of the Planing Mill façade, complete with 27-by-9-inch sashes between the double-pilasters. The rear, or western, wall again mimicked the Planing Mill with round-arched windows lining the wall.[136] This new space supported the final stages of car fabrication where an average of four cars were completed per week. Painting was also done here, with an average of eight cars in for painting at one time. By the time of initial occupancy in 1872, car construction and paint services had already outgrown this space.[137] Shortly thereafter, paint operations moved to a new building built specifically for the painting operations. It was built directly eastward from the Car Shop, separated from it by a horse-drawn transfer table.

Once paint operations moved, the space focused entirely on car construction. Forty feet (two bays) held iron planers and drills, 110 feet (five bays) constructed passenger cars, while

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[136] Just months before the fire of 1916, the Division of Valuation completed a documentation of the original structure. This shows exactly what the fire destroyed. *Valuation*, II, 407-416.

[137] "The Railroad Works at Sacramento," 1872, 86.

another 60 feet (three bays) repaired passenger cars.[138] In the early 1890s, the shops expanded yet again with an annex, referred to as the Pattern Shop. Extending southward, the new 90-by-96-foot building lengthened Car Shop No. 3 by four bays. The double-pilaster facade continued along its eastern length, but being of two-story construction, the addition appeared to be a separate building from the Car Shop. Built to increase space for car work on the first floor, the Pattern Shop occupied the second floor. Removed from the activity below, yet still close the surrounding foundries, the Pattern Shop was the middle step in the process of making new parts. Based on the drawings from the Drawing Room, the pattern makers produced wood patterns and then sent them to the appropriate foundry, where sand molds were made and parts cast for engines, cars, boats, machinery, and a variety of other fixtures. In addition to making the patterns, the Pattern Shop stored all of them for future use. This new addition provided a necessary and separate space for a process essential to the SP shops.[139]

At the turn of the century, several pieces of new equipment improved car and materials handling. An electrically driven transfer table replaced the horse-drawn model for aligning cars with tracks in Car Shop No. 3 and the Paint Shop. An elevator

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[138] "CP Railway," 1877, 1461.

[139] "Car Shop No. 3: Proposed Changes Plan," *Southern Pacific*, Sacramento Shops, Tube 44, Rec. 909, CSRM, December 6, 1916. P. Peek, "Modern Pattern Plant at Sacramento Shops," SP *Bulletin*, November 1921, 25.

installed in the northeastern corner of Car Shop No. 3 eased transport of materials between the two floors. After the Planing Mill was reconstructed from the fire of 1898, the building lacked a second floor doorway on the eastern wall, but the elevator, which dates from 1899, served the second floor of both buildings.[140]

A fire on November 26, 1916, nearly destroyed Car Shop No. 3. Only the five northern bays escaped harm. The southern wall shared by the Car Shop and the Pattern Shop (which would later burn down ca. 1990) acted as barrier to the spreading flames and saved the newer building and its contents. The brick wall on the east side survived the fire, and it was retained in the replacement structure.[141] Seeing that the brick walls halted the spread of the fire, measures were taken to include brick firewalls in the reconstruction. As documented by the *Sacramento Bee*, the preventive measures included,

> No provision be made for the storage of inflammable material overhead in the roof trusses. That two fire walls be constructed at proper intervals, provided with usual fireproof doors at passage ways. This fire emphasizes the fact that the pipe line system furnishing water to the shop

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[140] In 1916, the elevator stood on a 12-ft. x 12-ft. platform with a 20-ft. lift attached to an electric hoist. It was powered by a "P. G. E. Company series wound 500V, 25 HP Motor, street car motor with pinion removed, direct connected to Worm Geared Hoist, made by A. J. McNiccolds Company, San Francisco, in 1899." This motor replaced the "old motor that was part of the Original Hoist." *Valuation*, II, 408 and S16. See also "Floor Plan of Cabinet Shop for Cleaning Contract," April 10, 1914.

[141] The "walls of the building were not damaged. The company states that none of the patterns were destroyed. No one was injured." "SP Shops Damaged by $43,000 Fire," *Sacramento Bee* (November 27, 1916): 1.

> grounds is inadequate, the pipes being entirely too small to furnish water in sufficient volume or pressure for firefighting purposes.[142]

The company completely rebuilt the structure in the next year, increasing its height and width in the process. Moving the rear wall of the middle bays to the west by about ten feet increased floor space and better accommodated longer cars.[143] The firewalls divided the shop into departments of four or five bays in length. A double clerestory roof allowed increased the window area, with rows of windows lining both clerestory levels. After completing reconstruction of the destroyed section, the company replaced the northern five bays to match the new construction, except the original foundation plan was retained. All five of the bays were constructed with two floors, whereas the old Car Shop No. 3 had a second story over only two bays. A small portion of the dividing wall from the original structure protrudes on the current floor plan, reminiscent of its former purpose. To raise the new building, walls were built up from the

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142 "SP Fire Laid to Careless Workman," *River and Railroad: The Bee's Special Service* (December 4, 1916): 10.

143 "Note: 202 feet of this building was [sic] destroyed by fire since June 30, 1916 and the entire building has been rebuilt and altered since that date. Computation following are [sic] for building as existent on valuation date June 30, 1916 and do not apply to building as it is now on August 24, 1920." Valuation, II-407. The wood floor on the second floor had been used for about thirty years in 1946, thus dating the reconstruction of the northern portion to the year following the completion of the Car Shop destroyed by the 1916 fire. "Repair Floor in Electric Shop, Sacramento Shops," GM No. 34253, Sac-12936-B, November 7, 1946. See photograph with the southern portion of the Car Shop reconstructed and the northern half with its original structure. Neg. No. 23123, CSRM Collection, November 1, 1917.

existing wall connected to the Planing Mill. The original height of Car Shop No. 3 can be seen on the existing northern wall.[144]

While buildings exhibited new measures in fireproof construction, cars reflected similar characteristics. Steel passenger cars, introduced in 1906 and built in large numbers after 1910, had become common by the 1920s. Initially supported by the United States Post Office to provide increased safety for its employees in Railway Post Office cars, they increased safety for all passengers. The Sacramento Shops made some of the earliest prototypes, but SP turned to car builders like Pullman and American Car and Foundry for most of its new cars. Nevertheless, the shops were responsible for their maintenance and refurbishing. After the reconstruction of the shops from the 1916 fire, Car Shop No. 3 had the height and width needed to better support steel passenger car repair. The new truss system supported "overhead geared pneumatic hoists" over four tracks and provided the other nine tracks with sufficient surrounding workspace.[145]

The volume of passenger car work began to decline in the 1930s, but space was needed for diesel locomotive maintenance

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[144] Photographs from October 5, 9, and November 11, 1917, documenting progress of reconstruction. Neg. Nos. 19016, 23122, 23123, and 23125, CSRM Collection, 1917. The fire of 1916 prompted an investigation of various fireproofing materials and designs. Firewalls were the most significant introduction into the new shop, but roof and window designs were also investigated. "Car Shop No. 3: Proposed Changes Plan," 6 December 1916.

[145] L. A. Mitchell, "Development of the Steel Passenger Coach," SP *Bulletin*, June 1921, 14.

once SP began to acquire diesel switchers in 1939, a need that grew rapidly with the large diesel deliveries starting in 1947. Passenger car repair and refurbishing moved to the Paint Shop to make room for diesel operations. Diesel locomotives consisted of numerous components that could be removed and rebuilt in specialized shops, and the segmented building offered each department its own space. By the mid-1940s, the Electric Shop, Pipe Shop, Air Compressor Shop, and Truck Shop had replaced passenger car refurbishing entirely in the building.[146]

By 1946, the wood floors on the second floor of the northern section of the building had become seriously deteriorated from hard usage. Then supporting the Electric Shop, the "rough, worn, and splintered" wood floors needed renewal for safety and fire prevention. They were coated with a fireproof mastic of "dry cement and aggregate with an emulsion binder . . . reinforced with expanded metal" that served the building for the rest of its service life.[147]

To improve efficiency, the SP's engineers strove to eliminate, or at least streamline, vertical traffic between floors. The elevator dating from the early twentieth century was

146 "Repair Roof of Car Machine Shop Building and Install Ceiling Over a Portion of the Upholstery Shop on the Top Floor of the Building," GM No. 48133, 15 March 1951. A wash and locker room replaced the Pattern Shop when it moved to the Planing Mill in 1945, and it was used through 1955. "Improve Washing Facilities in Car Shop No. 3 Locker Room, Sacramento General Shops," GM No. 64360, Sac-15334, November 11, 1955.

147 "Repair Floor in Electric Shop, Sacramento Shops," GM No. 34253.

a major bottleneck to the smooth flow of materials. A 25-horsepower traction-type electric drive motor (predating 1916) attached to a hoist (dating to 1899) had survived the 1917-18 renovation of Car Shop No. 3. Aside from slow operations, maintenance of the obsolete elevator was costly, and repairs would barely get it past any state inspection. Moreover, an operator had to attend the elevator whenever it was in use, increasing its annual operation costs. In 1949, a new, automatic, electro-hydraulic elevator replaced the old one. The shops designed the outside shaft, but purchased the elevator itself from the San Francisco Elevator Company, Inc. The shaft was of "metal clad and fireproofed construction to suit new equipment installed." Today the freight elevator protrudes from Car Shop No. 3 and the Planing Mill, still enclosed in its fireproof, corrugated iron armor.[148]

The building continued as a model of efficiency and convertible space. In October 1950, the Electric Shop expanded to the unit to its south, pushing the Locomotive Pipe Shop into new facilities. The Electric Shop had performed routine maintenance of diesel locomotive traction motors, and the new space allowed it to handle main generators and other electrical components as well. To completely rebuild traction motors,

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[148] "The current elevator is a traction type electric driven with 25 HP electric motor installed prior to 1916." M. L. Jennings, "Renewal of Elevator #13364 Car Shop No. 3, Sacramento Shops," GM No. 40614, Sac-13671, August 10, 1948. *Valuation*, II, 408 and 416.

workers had to rotate them between vertical and horizontal positions, necessitating the use of a crane. At the time, only the Locomotive Machine Shop had the necessary cranes. Since the operations there had declined, one of its three cranes was moved to the Electrical Shop. Symbiotically, the shops shared machines as well as space based on needs at the time. The crane installation forced the modification of three wood columns. Newly installed steel columns and girders supported the crane and the wood truss above.[149]

The new diesel operations in the old Car Shop shifted the flow of materials. Since cars no longer had to enter and exit the shop, most of the large doors in the eastern wall were closed in with windows or smaller doors. By the time the shops closed in 1999, the structure was an amalgam of design and materials. The eastern wall was original to the 1872 structure, having been salvaged from the 1916 fire. Each portion created by the divisional firewalls had been modified at least once to create entirely new and different spaces in a building that once consisted of fifteen identical bays. Altered columns, windows, and extensions all show how the architecture changed to meet new needs over time.

149 M. L. Jennings "Install Fifteen Ton Electric Crane in Locomotive Electric

BLACKSMITH SHOP

With constant exposure to the high temperatures and corrosive atmospheres of metalworking, the Blacksmith Shop exhibits the results of Southern Pacific's continuing efforts to build structures well suited to their original functions, but adaptable to changing needs. Despite having the newest walls of the standing shops, this building contains the oldest wooden roof truss structure on the site. Originally built in 1869, the 60-by-150-foot Blacksmith Shop stood just south of the Planing Mill and Power House, and east of the Machine Shop.[150] An overhead flat belt connected to the Machine Shop's line shaft (connected to the Power House engine by a separate belt) turned the Blacksmith Shop's line shaft, which was oriented in the north-south direction. Additional flat belts from this line shaft drove the shop's machinery. Like other buildings on the site, the Blacksmith Shop was designed to expand and adapt to the changing processes of a growing company. Constructed primarily of brick, its south end was originally a temporary wooden wall to allow for easy expansion. Within a year it received a 167-by-90-foot addition. Again, the construction was of brick, except for a wooden south wall. Wooden trusses supported the corrugated iron roof over both sections.

Shop," GM No. 47033, Sac-14105, October 13, 1950.

[150] "The Pacific Railroad Terminal Shops at Sacramento," 31 July 1869, 72.

The single-story structure enclosed the shops' iron forging operations, and the design was intended to withstand the high temperatures involved and mitigate them to provide the most reasonable working environment possible. As was the case elsewhere in the shops complex, the first attempt proved to be something of a disappointment. The brick pilasters, rounded arch windows, wooden truss and corrugated roof framed a structure whose design harmonized with the rest of the complex. The walls rested on a foundation of brick footings on a double-row redwood grillage.[151] Unlike many of the other structures, the Blacksmith Shop provided an open floor space as the span of the trusses did not require interior columns. The walls, 22 feet in height, lifted the roof and monitor to an elevation that allowed heated air and fumes to rise and exit. Horizontally pivoted sashes, not commonly used until the 1880s, lined both sides of the roof monitors over each section, providing the enhanced airflow needed to dissipate heat and smoke from the floor. Hoods and stacks exhausted smoke directly from the forges. Early pictures of the Blacksmith Shop show exhaust stacks lining the length of each wall, positioning the forges alongside the windows. These side windows, which opened at the top and bottom, allowed fresh, outside air in to replace the exhausted air. Additionally, they

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[151] *Valuation*, II, 371-376.

provided light to the men working the forges, at least during daylight hours.[152]

Blacksmith operations in this building did not change significantly over the fifty years it saw service. By 1880, fifty forges, two furnaces, a trip hammer, and other essential machines were in regular operation. In 1894, the shop consisted of two departments.[153] The first turned out "all wrought iron for new cars and locomotives," using the immense steam hammers, blowers, furnaces, punches, and forges that filled the northern half of the structure. The second department worked scrap iron into slabs. This department also included two more furnaces and another steam hammer used to make car axles.[154] The forges lined each window, while six cranes, two steam hammers, and three power hammers stood near the central line shaft. Similarly, forges lined half of the windows on the wider, southern half of the building, and steam hammers stood in the middle. The southern

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152 Undated Neg. No. 27414, n.d. (ca. 1878-1888). Neg. No. 5903, n.d. (ca. 1878-1890). Neg. No. SPX 12-4, SPX 183, n.d. (ca. 1873). All CSRM. Also Bradley, 42 and 163.

153 While the Blacksmith Shop described herein is the only surviving structure on site dedicated to iron working, it must be noted that Sacramento included a large Foundry, the Hammer Shop that directly augmented the Blacksmith Shop's operation, and a Rolling Mill by 1895, plus smaller non-ferrous foundries, making it one of the most extensive metal-working facilities in the West. These structures were located to the South and East of the present Blacksmith Shop.

154 "History of Sacramento County, Cal." 1880, 200. "The SP Company's Railroad Shops," 114. In the late 1800s, an additional blacksmith shop was built. Where the first shop provided facilities only to forge iron, the newer shop provided facilities to cast iron. "Plan of Sacramento Shops and Yards and Waterfront," May 14, 1906, Record ID No. 15226, CSRM.

end also contained a single track to enable the unloading of scrap iron and the loading of heavy, forged items.[155]

Like all departments, the Blacksmith Shop needed an office. Initially a single-floor, it was situated in the corner created by the building's two sections and measured 15 feet, 6 inches by 12 feet. After 1888, a second floor was added, and this structure served until concrete walls altered the L-plan of the Blacksmith Shop in 1939.[156]

The harsh atmosphere and heat of smithing proved to have an unexpectedly detrimental effect on the brick walls of the shop, particularly the relatively porous mortar. By 1915, it was evident that the northern section walls were seriously deteriorated and would have to be replaced soon. In 1917, the northern wall of the shop was torn down and replaced with a new brick wall featuring wider windows. Concrete lintels replaced the arched brick ones, allowing rectangular windows to stand almost the full height of the wall. Concrete had seen some limited use in the shops since the turn of the century, but like most new processes, materials or products, large-scale adoption was slow until it proved to offer a better return on investment than other materials.[157]

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[155] "Blacksmith Shop General Plan," September 5, 1918, Record ID No. 3536, CSRM.

[156] "Addition to office in Blacksmith Shop, Sacramento." Sacramento Shops Binder, Record ID No. 12346, October 1888.

[157] Neg. No. 18085F, CSRM Collection, n.d. (ca. 1917).

The atmosphere in the Blacksmith Shop continued to eat away at the brick walls, leading to a major renovation of the southern portion in 1927. A small item in an SP *Bulletin* noted that "[t]he historic Blacksmith Shop has been replaced with a modern well lighted shop." This "modern well lighted shop" introduced reinforced concrete construction to the shops, along curtain walls and very-large windows. While concrete had become commonplace in factory construction by 1927, it was a major innovation for the shops, especially since no major disaster caused this renewal.[158] Although some of the surrounding buildings of the original shops had been rebuilt after fires, the Blacksmith Shop had avoided a similar disaster. Thus, its original walls and roof—by then more than sixty years old—still enclosed major shop operations.

To avoid losing all production within the Blacksmith Shop during reconstruction, the company kept up operations within the northern half of the building while they rebuilt the southern portion of the building. The job was accomplished by erecting temporary supports for the roof trusses, demolishing the old walls, casting the new, concrete walls in place, lowering the roof back onto the walls, and installing the new windows. For an

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[158] With few concrete factories existent from 1890s, intense experimentation with concrete continued in the early twentieth century. By 1907, poured concrete became common for factory buildings. Reinforced with an iron or steel frame, the concrete provided fire resistance while the metal frame provided much of the structural strength. Bradley, 156 & 161.

old shop, the new structure was striking, and the large expanses of glass brightened the interior considerably. But even as SP's *Bulletin* raved about the "new well lit shop," only the southern half fit this description. The plan was to renovate the northern half soon after operations resumed in the rebuilt southern portion, but the Great Depression struck before that project could be launched. With the depressed economy and a reduced demand for railroad service, the northern half reconstruction was put off until the building's condition posed an undue threat to the workers, machinery, and operations. As it turned out, eleven years elapsed between the completion of the southern half in 1928 and the commencement of the northern half renovation in 1939. As with the earlier project, this renovation took about a year to complete.[159]

Numerous minor repairs kept the northern portion in service for a while, but by 1939, reconstruction of the 70-year-old structure could wait no longer, as repair costs and impending damage exceeded the cost of new concrete walls. Analyzing the situation, W. L. Hack noted that the "brick mortar has now deteriorated to such an extent that entire replacement of the brickwork is necessary. The truss roof is in fair condition and

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[159] As listed in the GMO index, construction started July 2, 1927, and was completed April 12, 1928, for GMO No. 73687, "Renew Blacksmith Shop." Construction started July 8, 1939, and was completed April 30, 1940, for GMO No. 7997 "Extend Blacksmith Shop." "Southern Pacific Sacramento Division, GMOs - Index [by GMO number]," CSRM.

will be retained."[160] The rotting redwood grillage foundation caused the brick walls to crack and lean outward. Further, the electric and acetylene welding operations within the building demanded more space.

Though the Blacksmith Shop stood half brick and half concrete for more than a decade, little reveals the longstanding state of unmatched walls. The similar wood patterns imprinted on the concrete walls of both sections reveal that both sections were poured in place using wooden forms.[161] Though it may appear that the building was cast as a single entity, a closer inspection reveals that the pilaster at the meeting point between the northern and southern half (and where the former 60-foot width meets the 90-foot width) measures 2 feet, 4 inches wide, whereas all other pilasters measure 1 foot, 3-1/2 inches wide.

The breaks in roofline and clerestories also identify this division point. In reconstructing the Blacksmith Shop, the original, wooden roof trusses from the 90-foot and 60-foot structures were retained, but the older roof could not span the new 90-foot width of the rebuilt structure. When the northern

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[160] The photos contrast the sloping brick wall with the new concrete wall. They show the northern brick wall constructed in 1917, the western wall from 1869, and the 1927 concrete wall. See photos dated April 7, 1939, and numbered 1260-1 to 1250-5. W. L. Hack, "Remodel and Extend Blacksmith Shop," January 10, 1939, GM No. 7997 Sac-10554/10534, CSRM.

[161] Wet concrete was poured into wooden forms around the iron or steel and allowed to set. While "new reinforcing bars connected to those embedded," the wood formwork defined the position and design of the final wall. See photo of the wooden framework for the poured concrete on the northern half of the

half of the building was widened, a line of steel columns was installed in place of the old east wall to support that end of the trusses. A nearly flat roof extension covered the 30-foot span between the column line and the new concrete east wall. As with the southern reconstruction, the new structure doubled the window area. These windows, which were purchased rather than built on-site like the earlier, wooden windows, had metal frames and mullions. The doors, however, reveal the decade difference in construction dates. Wooden doors with square hinges bolted into the southern portion's concrete walls contrast with the newer doors on the northern half. Galvanized flat sheets cover the newer doors and hinges connect to a steel bars set into the pilasters.[162] The metal-covered doors are evidence of SP's continued efforts to improve fire safety. Close inspection also reveals subtle differences in the texture of the concrete between the two portions. The pattern of the form boards is more pronounced in the southern half, but the surface finish is somewhat rougher on the northern walls. The workers who toiled in the shop over the years no doubt overlooked details such as these, but they provide important clues to the structure's history.

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building. The southern part of the Blacksmith Shop is concrete. Neg. No. 7077c, CSRM Collection, n.d. (ca. 1939-40). Also Bradley, 56.

[162] "SP Co. Blacksmith Shop Extension: Details East Wall," June 14, 1939, Sacramento, Cal. Dwg. 8453, Sheet 4, GM No. 7997.

In order to reduce capital costs within a given fiscal year, the shops would sometimes perform one major reconstruction project while proposing a less-demanding, yet equally essential, project for the following year. The reconstruction of the northern portion illustrates how this was done. The 1939 project to replace the walls reused the existing roof trusses and corrugated iron roof sheets to keep the project cost down to an amount management would accept. But by completion, "betterment" plans for the roof were already in the works.[163] The deteriorating, leaky roof badly needed replacement, and shop supervisors wanted to replace it with corrugated transite,[164] a material already present on the southern half of the roof. W. L. Hack, superintendent of the shops, expressed the need in a written request for an Authorization for Expenditure (AFE) to,

> . . . renew the corrugated black iron roof on the northerly 145' of Blacksmith Shop to corrugated transite roof.
>
> The brick walls of the northerly 145' of the old Blacksmith Shop were renewed to concrete in 1939.
>
> The main and clear story roof over this portion of the building has been in service over forty years and is now in very poor condition.
>
> The iron has deterioration to such an extent that it will not hold the nails fastening it to the sheathing. It

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[163] W. L. Hack, "Renew Corrugated Iron Roof to Corrugated Transite Roof on the Portion of the Blacksmith Shop," GM No. 10780, Sacramento No. 11061, January 12, 1940, CSRM.

[164] Transite was a Johns-Manville Corporation trade name for its asbestos-reinforced Portland cement products. Pre-cast into sheets and pipes, it was widely used in the United States as a durable, fire-resistant construction material. Even though Transite was a trade name, “transite” was widely used to describe any asbestos-cement material. This is not to be confused with the current product, Transite HT, which does not contain asbestos.

> has also rusted through in places, which permits considerable amount of water to leak into the building. This is hazardous to the weling of the Babbett Operators.
>
> To eliminate this condition, it is desired to renew the iron roof to corrugated transite, which is the same type of roof on the remainder of the building.[165]

Two months after the written request, L. B. McDonald, CWM of shops, approved an AFE for $2600 of betterments to install a transite roof, and the new roof was soon in place. Still present on the structure today, the roof appears to be corrugated metal from afar, but the absence of rust indicates its true material.

The change from steam to diesel power altered the amount and nature of Blacksmith Shop work. Diesels did not require the number of custom, forged parts that steam engines did, but the various diesel-engine components needed specialized spaces for their inspection and repair. Between the 1930s and 1960s, the building continued to house the Welding Shop in its northern five bays, and a new Rod Shop moved into the remaining northern bays. Blacksmith operations did not disappear entirely, though, but by the 1960s, the building enclosed a Locomotive Machine Shop in addition to its blacksmith, rod, and welding operations.

The Blacksmith Shop illustrates a different kind of resilience than do the other buildings. Unlike those structures, the Blacksmith Shop's 19th-century brick walls did not hold up well. The concrete walls from 1928 and 1939-40 exemplify a form of 20th-century industrial construction that has endured for over

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165 Spelling kept accurate to source. *Ibid.*

60 years. Where most other buildings on the site now vary from bay to bay and window to window, the shop's exterior walls and large metal windows remain as they were when installed in 1928 and 1940. Although the wall materials are modern, the overall design of the building stems from the same principles of order, balance, strength, and adaptability found in the 19th-century structures. Some of the hinged doors have been changed to sliding doors, and a few chunks of concrete have fallen out, but it otherwise stands as designed. The use of wood for the roof trusses proved to be a fortuitous choice. In the corrosive atmosphere of this shop, iron trusses would no doubt have required numerous repairs. Likewise, the corrugated transite roofing remains in excellent condition, in contrast to the metal roofs elsewhere around the shops that demand recurring attention.

PAINT SHOP

Painting was initially done in a wing of the Planing Mill, but the volume of work quickly outgrew the limited space available there. By 1872, shop managers realized that a facility devoted entirely to the painting process was sorely needed, even though funds were limited.[166] To fulfill this need, the

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[166] "The Railroad Works at Sacramento," 86.

Sacramento Shops erected a new building located east of, and parallel to, Car Shop No. 3. The new Paint Shop consisted of one main building measuring 70 feet by 265 feet, with five parallel wings to the east, each measuring 70 feet by 20 feet, and a 20-by-44-foot, two-story office at the northeast corner. A portion of the office's second floor sat directly over the north painting bay. Construction was brick, with a corrugated metal roof on wooden trusses. Tailored exclusively for painting and varnishing, each bay had large windows or doors in three of its walls for greatly improved natural light and ventilation, while the connecting walls to the main building had "closely fitting doors."[167] In contrast to the roof clerestories that provided other buildings with light and airflow, the Paint Shop relied solely on skylights for light from the roof. Some larger shops around the country featured continuous skylights by the time the Paint Shop was built, but these alternated with metal roof panels.[168] The natural light was ideal for painting and color control.

Unlike most of the shops, the Paint Shop needed no power tools or heavy machinery, so it could be located away from the central Power House. A remote location also reduced smoke and

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167 "CP Railway," 1461.

168 Skylights appeared as early as 1825 on the east coast, and they were common in factory construction by the 1850s. Additional improvements allowed the Pennsylvania Railroad to install continuous skylights up to 13 feet wide on some of its shops by 1873. Bradley, 187.

dust from the other shops that could contaminate the wet paint. Since painting was the final step in car construction or renovation, the cars could easily be moved around on their own wheels. They were conveyed to the Paint Shop from Car Shop No. 3 by way of a 68-by-265-foot transfer table between the two buildings. Entering the west side of the Paint Shop, a car was rolled through the open area of the main building and into one of the five painting bays, where "some of the most skillful [painters] in the U. S. [who] are employed in this department"[169] painted, varnished, and lettered it for the public eye. Upon completion, the car would exit the building through doors in the east end of the bay ready for service.

An 84-by-183-foot addition, projecting eastward from the south end, was built ca. 1890-92. The transfer table pit was extended 23 feet to service the three new tracks into this addition, as well as the new Pattern Shop addition to Car Shop No. 3, which was built during the same period.[170] As with the original Paint Shop structure, the addition was constructed of brick with a corrugated metal roof, but riveted steel trusses were installed instead of wooden ones. The addition had no interior columns.

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169 "The SP Co.'s Railroad Shops," 1894, 116.

170 "Ground Plan of Paint Shop at Sacramento," July 28, 1898, Binder ID 7001, CSRM.

By the late-1890s, many passenger cars had increased to around 80 feet in length, too long to fit in the shop's 70-foot painting bays. This, along with the increasing volume of freight- and passenger-car work forced the company to drastically reconfigure the shop. In lieu of individual painting bays, one large space could accommodate at least eight passenger cars, or a greater number of shorter freight cars.

Although surviving records fail to reveal the exact date, extant drawings indicate that the Paint Shop underwent a major modification sometime between November 1898 and June 1903.[171] Four of the five painting bays were demolished and replaced with a single 114-by-160-foot room that was spanned by two sets of 80-foot trusses. The wall sections between the old painting bays were also removed and replaced with steel columns, making the new area and the main portion of the original building one contiguous open space. The revisions retained the north paint bay, because its walls served to support part of the second-floor office and it housed the stair to it.

With these changes the Paint Shop acquired a rectangular footprint, except for the open alley left just south of the remaining paint bay. At some later time, this alley was enclosed and roofed as well. The surviving paint bay became a central

[171] Drawings that show the old and new footprints on these dates are a sketch included in "The Shops that Were Destroyed," *Sacramento Bee* (November 8, 1898): 7, and "Ground Plan of Shops Showing Future Extensions," June 1903, Record ID No. 14544, CSRM.

office room, Workspace more than doubled and track space easily tripled. Eight tracks were now covered, in place of only four in the demolished bays. The structural steel mullions and girders permitted an open space formerly unattainable with load-bearing brick walls. Skylight sashes lining the corrugated, galvanized iron roof allowed natural light to illuminate the area.[172]

Where the Paint Shop had been built as a highly specialized facility, this modification converted it into an open-plan structure capable of accommodating not only more cars, but also a wider range of activities should the need arise. Other surviving drawings from the time show that SP's engineers continually thought about possible changes and expansions, so the conversion to an open plan that could serve a variety of purposes made sense. At least one drawing shows this building being converted into a car shop, with a new paint shop to the east.[173]

As it had done when rebuilding structures destroyed by fire, the conservative Southern Pacific retained as much of the original Paint Shop building as possible, and it designed additions that blended in well with the existing walls. Evidence of the addition to the office is more apparent inside. The outline of added ceiling delineates old and new, and while the

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172 "Ground Plan of Paint Shop at Sacramento: Dotted Lines Show Proposed Change," July 28, 1898. *Valuation*, II, 428-431.

173 "Proposed Extensions of Car Shops at Sacramento," April 1904, Record ID No. 14545, CSRM.

second floor was initially insulated with a plastered wall, the extension left bare brick walls.

The Paint Shop's earliest floors were wood, but by 1917, the entire shop had concrete floors.[174] This change produced a major reduction in the amount of dust and dirt in the air, with a corresponding reduction in paint contamination.[175] By the time the 1917 Valuation was performed, the alley had been covered with a roof of corrugated iron, providing shed space for a heater tank, wash sink, urinal pipe, and other miscellaneous items. The latest addition here, with its wire-glassed entry, is in marked contrast to the reset of the building. The alley enclosure brought the Paint Shop structurally to its current state.

In the 1920s, enough track spanned the floor to provide space for twenty-three cars at once. Wooden cars had "paint removed by burning process" while steel cars were usually sandblasted. Except for the primers used, the painters followed the same painting process for both wood and steel cars. The Paint Shop also provided services for a wide variety of railroad items other than cars, including glass and mirror finishing, sign painting, and shop buildings and equipment.[176]

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[174] *Valuation*, II, 432.

[175] "Building No. 35: Paint Shop/Roof: Corr/Walls: Brick/Floor: Concr.," December 6, 1917 Plan," Record ID No. 14547, CSRM.

[176] A. D. Williams, "From Bolts to Walking Beams," SP *Bulletin*, February 1922, 28.

With the onset of the Great Depression, passenger traffic began to decline on SP, as it did elsewhere, a decline broken only by the World War II years. As passenger trains were discontinued, the road scrapped its older cars, especially the remaining wooden ones. By 1950, SP's premier passenger trains, such as the *Daylight, Sunset Limited, Lark, City of San Francisco, San Joaquin Daylight*, and *Shasta*, had been re-equipped with lightweight, streamlined cars, and these new cars, especially the stainless-steel ones from Budd, required less maintenance than the older cars. The Sacramento Shops continued to refurbish, remodel, and repaint passenger cars, but far fewer than during the 1920s.

The reduction in work after World War II allowed SP to reallocate shop space once again. The Paint Shop was sectioned off to house other passenger car departments, and by 1946 it housed car repair as well as painting within its large open area. In the northern section of the building, the scrub room, lye pits, rubber room, paint storage room, paint mixing room, and varnishing room were adapted to the space formerly occupied by the office and old painting bay. The Carpet Shop moved into the northern two-story section during the 1950s. There remains evidence of a silk screening room on the east end of the second floor. Smaller rooms were partitioned off along the southern wall to make room for the Air Conditioning (AC) Department, a tool room and an office. Air conditioning had been introduced in the mid-1930s to create a clean, comfortable environment for passengers in all weather conditions.[177] The introduction of paint spray guns powered by compressed air substantially reduced the time required to paint and stencil a car, even though some of the modern paint schemes were more complex and multi-colored. Lettering was rarely done by hand, but regardless of the dwindling service, operations continued so "nothing went out unpainted."[178]

The Paint Shop gradually acquired all of the passenger car repair functions during the 1950s. The new shops associated with diesel maintenance pushed the passenger car operations out of the former Car Shop No. 3.[179] The southern portion of the Paint Shop building soon was used "solely for repair of passenger cars . . . [with an] average output per month [of] five cars receiving heavy repairs and twenty-five cars undergoing light repairs."[180]

By 1953, the 80-year-old brick building needed constant attention. Coated with dirt and paint overspray, the brick

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177 "Proposed Placement of Wiring and CC-5 Receptacles in Passenger Car Repair and Paint Shop," February 2, 1946, by GEJ, in M. L. Jennings, "Renew Portable Electric Tool Outlets and Wiring In Passenger Car Shop," GM No. 32786, Sacramento No. 13040, February 5, 1946, CSRM. See also "Comfort: 'Man-Made Weather' in AC Cars is Boon to Train Travel," SP *Bulletin*, October 1935, 10.

178 Ronald Rypinsky, Interview by Don Zaro, November 25, 1996, CSRM Oral History Collection, 2.

179 The building identified as Car Shop No. 3 came to house the Electric Shop, Traction Motor Shop, Air Brake Shop and Car Truck Shop. See Car Shop No. 3 section for further information regarding this change. By 1950, the Paint Shop was labeled Car Shop No. 3 on plans for the GMO 44241, Sac-13957.

interiors had lost what reflectivity they had. Since the shop had been designed to use natural light, it had become a dingy place to work, so the company decided to paint the interior white. It was a good idea, but it proved to be something of a challenge, requiring the application of two coats of white paint on the walls, gables, and roof trusses to get an acceptably bright finish.[181] The exterior, too, required extensive maintenance. Corrugated iron roofing rusted, skylights leaked, and glass broke, creating openings for water to enter whenever it rained. Employees had to work on scaffolding to reach some portions of the cars, and wet scaffolds increased the chance a man might slip or fall. Repairs, however, were only made as needed; no complete roof replacement was ever done as it was on the Blacksmith Shop. Consequently, a variety of skylight window designs appeared on the roof. During the 1950s, aluminum skylights replaced many of the rotting wood and steel ones, but these later gave way to corrugated fiberglass panels.

The constant shifting of operations made temporary structures necessary when high-priority functions pushed others out of permanent buildings. Painting moved into a temporary shed to the east of the Paint Shop for a time, but its small size and non-fire-resistant construction invited disaster and prompted some improvement. Today, doorways numbered "2" and "3" can be

[180] M. L. Jennings, "Repaint Portion of Interior of Coach Paint Shop, Sacramento," GM No. 58678, Sac-14780, August 19, 1953, CSRM.

observed to have sliding fireproof doors, where no other Paint Shop doorway does.[182] They are the remains of a painting annex built west from these shop bays in 1955. To meet fire codes, the engineers designed the annex with concrete block walls, fireproof doors, and an interior painted with fire-resistant paint.[183] Though the building has since been demolished, the annex did provide safe conditions for the painting needs of the time, which were estimated to be 10 percent passenger cars, 60 percent Stores Department work, and 30 percent miscellaneous work.[184]

By the time of Amtrak's creation in 1971, SP was doing as little as possible to support the few passenger and commuter trains it had not been allowed to discontinue, and Sacramento soon terminated all passenger car maintenance operations. But the Paint Shop building did not remain vacant for long. SP needed space for small component rebuilding operations of the GRIP program to refurbish locomotives, and the large open areas of the Paint Shop were readily adaptable. By the time Union Pacific closed the Sacramento Shops in 1999, many of its

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181 *Ibid.*

182 Looking at the entire western wall of the Paint Shop, the fifteen numbered arches each hold distinct doorways, though they were initially identical. Door No. 4 bears a resemblance to the original eleven doors. The southern four doors were part of an extension, circa 1890, and the brickwork in their arches varies slightly from the first eleven. Gravity operated, "automatic," fire doors also protected openings connecting major areas within the shop.

183 R. A. Miller, "Construct Paint Spray Building-Car Shop No. 3," GM No. 63217, Sac-15146, 12 April 1955, CSRM.

184 H. H. Means, Estimator, Memo referenced by George Massi, Paint Foreman. 14 April 1955, in GM No. 63217, Sac-15146, April 12, 1955, CSRM.

buildings had already been demolished, but the versatile Paint Shop survived to the end.

CAR MACHINE SHOP

Built about 1888, some twenty years after the initial shop construction, the Car Machine Shop largely matched the other buildings in structure and design. Few differences marked its newness. Its structure offered wider bays and more open space, and it included a clerestory that matched that of the original Planing Mill. The two-story building measured 75 by 190 feet. As the volume of car construction grew, the Car Machine Shop became increasingly essential to both interior and exterior car work. The first floor, being nine bays by three bays, included large doors in both ends of the building. It housed operations for car construction and associated machinery, while the second floor held the Plating Department and Upholstery Shop. The Plating Department finished locks and car trimmings in plating baths for silver, copper, nickel, and brass. The Upholstery Shop included a storeroom, dyeing room, sleeping-car equipment room, and a hair store and picking room above the storeroom where "material for stuffing cushions lounges etc. are cleaned."[185]

Only ten years after it was built, the Car Machine Shop burned almost completely in the 1898 fire that also destroyed the Planing Mill next door. The extent of damage to the building is clear from this account in the *Sacramento Bee*,

> The debris of the burned railroad shops is being removed preparatory to the erection of new shops, which will undoubtedly be built on the latest modern plans.
>
> On account of the great amount of machinery, which has been damaged to such an extent that it cannot be used again, the work of clearing the debris away will necessarily be exceedingly slow.
>
> The high brick walls that were left standing are in danger of falling onto adjoining shops, and these walls will be either braced or entirely taken down before any headway can be made towards removing the cumbersome machinery and iron scraps, leaving a clear foundation for the new shops.[186]

Despite the severity of the fire, the standing walls exhibited the best fire-resistant construction of the age. The wood joists and floors fell to the ground while leaving much of the walls intact. As with the Planing Mill, rebuilding of the Car Machine Shop began immediately, but SP's conservatism guided the reconstruction. Though the machinery and cars within were totally destroyed, over half of the four exterior walls could be salvaged. Based on similar catastrophic incidents, the shops cleared out the fallen debris and separated ruined from reusable

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185 "The SP Company's Railroad Shops," 116. "Fierce Fire at the Shops: Important Departments Suffer From This Morning's Blaze," *Sacramento Bee*, 8.

materials. Salvaging all it could from the remains, the company rebuilt the shop to the old plan, within the surviving walls and on the old foundation.

Though the *Bee* stated the facilities would be "on the latest modern plans," the term *modern* must be seen in relative terms. In practice, it meant primarily the use of riveted steel roof trusses and new, horizontally pivoted clerestory windows. In other respects, the rebuilt structure essentially duplicated the old one.

Access to the building's second floor—either as built or rebuilt—is not entirely clear. No evidence of an inside stairway between them now exists, though a relatively modern, aluminum stair was installed outside the north wall at some point. The first evidence of a second-story bridge connecting the Planing Mill to the Car Machine Shop exists in plans for a proposed bridge after the fire of 1898.[187] The existing bridge corresponds with the measurements in this plan. Since the Planing Mill was rebuilt at the same time, it may be that the Planing Mill's elevator and stairs were intended to serve the second floor of the Car Machine Shop as well. The bridge also provided the most direct access—through the Planing Mill—to the

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[186] "Clearing Off The Debris: Busy Scenes on the Site of Monday's Fire," *Sacramento Bee*, 5.

[187] "Sketch of Proposed Bridge Bet. Planing Mill and Car Machine Shop at Sacramento," April 5, 1899, Ref. No. 6599, CSRM.

Privy's upper floor. Stairs do rise to the attic hair store from the Car Machine Shop's second-floor central hall.[188]

Tracks run east-to-west in each of the first floor's three bays, though only the track along the north wall extends all the way through the building.[189] By 1914, however, most of the first floor had been converted into a wheel shop, including additions and modifications to the in-floor rails to accommodate wheelsets. Doors on the east and west ends allowed the entry and exit of wheelsets along the tracks.[190]

As with the original structure, specific areas of the second floor were sectioned off to hold the various operations of the Upholstery Shop and Plating Department. By 1922, passenger-car operations were limited to refurbishing, but the Car Machine Shop continued to house supporting functions. The Plating Department renewed all metal parts "economically and thoroughly." Cabinet hardware, silverware, and a wide variety of other metal parts—even locomotive headlight reflectors—were cleaned, re-plated, and polished. The Upholstery Shop renewed old cushions, pillows, tapestry, and curtains. A new vulcanizing process even

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188 "1914 Floor Plan of Upholstering Shop: 2nd floor east of Car Machine Shop," April 11, 1914.

189 "Floor Plan of Car Machine Shop for Cleaning Contract," April 11, 1914, Book 55, No. 9932, CSRM.

190 "Ground Plan Showing Location of Wheel Machines in Car Shop." August 12, 1914, Special 10058, CSRM Collection. See also Williams, 28.

"reclaim[ed] old rubber material," which was formerly unsalvageable.[191]

As noted in other sections, the coming of diesel locomotives in the 1940s had major effects on space allocations within most of the shop buildings. The Car Machine Shop proved to be no exception. In the Wheel Shop, new machines provided efficient reconditioning of wheel and axle units. By the 1950s, the shop handled diesel wheels, as well as engine- trailing- and tender-truck wheels for the remaining steam locomotives, which had formerly been processed in the Locomotive Machine Shop. For the wheel-slip control on diesel locomotives to work properly, the diameters of every wheel on a locomotive had to be virtually identical. This need for increased precision, coupled with an increased volume through the Wheel Shop, justified new, high-speed machinery, which, in turn, necessitated better lighting and layout modifications to improve production flow.[192]

These changes caused alterations to the building's exterior appearance and interior arrangement. Built with reasonably large-span bays, the Car Machine Shop could be readily adapted to meet the new requirements. In 1945, the doors, tracks, tool

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191 "1914 Floor Plan of Upholstering Shop: 2nd floor east of Car Machine Shop," April 11, 1914. See also Williams, 28.

192 The volume of wheel work increased at Sacramento as SP closed smaller, outlying wheel shops. F. E. Russell, "Install Cranes and Crane Runway In Car Machine Shop," GM No. n/a, Sac-13130A, January 23, 1947. M. L. Jennings, "Improve Lighting in Car Wheel Shop," GM No. 46252, Sac-14080, August 29, 1950, CSRM.

shed, and office space all were repositioned to accommodate a larger wheel lathe and its supporting equipment. Prior to the arrival of the new lathe, workers moved the southern track four feet further south, and they rebuilt the corresponding end doors to line up with it. Shifting these non-structural elements may have been an esthetic sacrifice, but it was far easier and cheaper than altering internal columns to obtain the necessary open space. So modified, the Wheel Shop continued in service for many more years.[193]

Other changes followed as the building adapted to meet new needs. The 1945 move of the Upholstery Shop across to the Planing Mill opened space for increased plating operations. This move also permitted expansion and movement of the lacquer spray room from a 7-by-8-foot room to a larger, 12-by-20-foot one in 1950. The SP incorporated the latest fireproofing, including a Flexolith[194] floor, plaster walls and ceiling, spray booth with exhaust fan, automatic sprinklers, explosion-proof electrical fixtures, and a steam-heated system for drying the lacquer work.

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[193] On other occasions, column removal or relocation was necessary to accommodate new machinery. Twelve columns supporting the second floor bear evidence of such modifications. Longitudinal beams were also added as necessary to support second-floor joists. For this change, see M. L. Jennings, "Alterations and Improvements at Car Wheel Shop," GM No. 30636, Sac-12849, May 23, 1945, CSRM.

[194] Flexolith is the trade name for an industrial floor coating manufactured by Dural Corporation (now Tamms Industries) of Kirkland, IL. The material referred to here was an oxychloride cement, which may differ from the current product sold under the Flexolith name.

The spray room, complete with these modifications, remains largely intact today.[195]

The performance of the Flexolith floor in the lacquer spray room led to its installation in other areas that were susceptible to chemical deterioration. A lye solution in steam-heated vats located near the entry to the bridge on the second floor cleaned metal parts prior to plating. These vats were prone to boiling over, and when one did, some of the caustic solution would seep through the wood floors and drip onto the floor—and sometimes workers—below. After twenty years of this, the lye had eaten away enough of the floor to seriously weaken it, threatening the workers and machinery below. The wooden flooring around and underneath the vats was replaced and surfaced with Flexolith. Since the vats had to be removed to replace the floor, the company took the opportunity to clean or replace piping as necessary to minimize future problems.[196]

As they aged, all of the Sacramento Shops buildings required increasingly costly maintenance, and one of the most expensive items was roofing. By 1954, the Car Machine Shop's 40-year-old corrugated iron roof needed replacement. Faced with a significant investment, SP decided to make sure the entire roof

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[195] M. L. Jennings, "Renew Lacquer Spray Room to Fire Resistant Room In Car Machine Shop Building, Sacramento Shops," GM No. 44593, Sac-13973, February 28, 1950, CSRM.

[196] M. L. Jennings, "Renew Floor in Lye and Acid Cleaning Room, Second Floor, Car Wheel Shop Building, Sacramento General Shops," GM No. 52222, Sac-14480, June 13, 1952, CSRM.

structure was as sound as the new roof sheets. Workers "scrape[d] and clean[ed] all rust and dirt off of the steel roof frame and repaint[ed] it with one coat of red lead and one coat of paint to preserve structure and materials inside."[197] This roof remains in good condition.

Through its several alterations, the Car Machine Shop exhibits a durability and adaptability that was a hallmark of most structures on the site. In a very real sense, this engineered building was never "finished" during the shops' lifetime. Its final functions were quite different from those for which it was built. The altered doors, windows, walls, columns, and floors all exhibit an adaptability that was essential to its survival. The changing nature of railroad locomotive and car maintenance demanded extensive modifications to facilities. Had this building not been readily and economically adaptable to such changes, it no doubt would have met the same fate as the inadaptable Roundhouse.

PRIVY

Possibly the only three-story privy in existence, this building is one of the few on this site to have kept the same function throughout its life. While its fixtures, details, and exterior finish changed over the years, its basic design and service remained unchanged for more than 125 years. Built of brick in a style similar to that of the adjacent structures, the building stood 19 feet by 30 feet. Like other early buildings on the site, it was built on a redwood grillage and rubble foundation. As built, one of its defining characteristics was a tall ventilation stack. Before running water was available, this vent, visible in many historic photographs, extended high above the adjacent shops to ensure a ventilation flow that carried any foul odors away from the shop buildings.[198] This stack was removed after the installation of flush toilets significantly reduced this problem.

All three floors share a similar layout. A 7-foot-high partition divides each floor into two rooms, each with a row of nine toilets and one sink along the central partition. Currently, the first floor has two doors on each (north and south) end, one set for each room. The upper floors have doors only on the north end, with windows in their places in the south wall. This arrangement of doors on the first and second floors does not match plans in the 1917 I.C.C. Valuation Report, though records indicating exactly when they were changed have not been

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197 M. L. Jennings, "Renew Corrugated Iron Roof and Repaint Steel Truss Roof Frame on Car Wheel Shop," GM No. 58856, Sac-14960, July 16, 1954, CSRM.

198 *Valuation*, II, 473-477.

located. The first floor initially had only three entrances, two on the north side and one on the south side. The second and third floors had two doors each, located on the south side for the second floor and the north side for the third floor.[199]

Access to the building's second floor was via stairs located outside the building, an arrangement that freed all of the interior space for plumbing fixtures. Third-floor access was over a bridge from the Planing Mill's second floor. The Planing Mill once had doors on both floors opposite the Privy; a detail that supports the Privy being part of the Planing Mill's initial plans, even though it was built a few years later. After the fire of 1898, the Planing Mill's first-floor door was replaced with a window. Though the bridge between the Planing Mill and Privy has changed since the original design, the double-door archway on the Planing Mill's second floor aligns with the Privy's third-floor entrance. The arch was later closed in and now holds a single door.

The Privy was built using brick and mortar that proved to be soft and porous, and both materials deteriorated over time. In an effort to stanch this deterioration, the company resurfaced the exterior with a stucco material. Today, the stucco has fallen off in several areas to reveal the brick and mortar beneath. Both are fragile, particularly the mortar, which flakes

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[199] *Ibid.*

off like sand to the touch. Clearly, the mortar for this building was substantially inferior to that used in the large shop structures. Although portions of it have failed in recent years, the stucco coating did protect the original brick and mortar from the weather and halt their decay, and it represents yet another means the SP used to keep these aging structures in service.

MAXIMIZING USE OF AVAILABLE RESOURCES AND STRUCTURES

The Southern Pacific carefully accounted for any resource or product used within the shops. Further, the company weighed the cost of any proposed improvement or alteration against the expected benefit. This helped establish a system of checks and balances used to analyze the shop's efficiency and determine whether various items would be better manufactured in-house or purchased from outside vendors, or whether rebuilding would be preferable to the purchase of new equipment.

When the shops were first built, all railroad suppliers were located on or near the East Coast. Before completion of the transcontinental railroad in 1869, virtually everything the Central Pacific needed except wood and clay for brick had to be delivered from the East by ship. Even after the Pacific Railroad began operation, Sacramento’s remote location made self-sufficiency essential, and this ability and attitude influenced decisions about the shops' facilities and operations throughout its life. Having made major investments in expanding the shops' capabilities—both in labor and facilities—CP and, later, SP sought to get the maximum possible value out of them. Yet, the continually changing nature of the railroad business and the introduction of new, more-efficient equipment, machines, or processes usually meant additional investments that the company justified because the shops were so capable.

Unlike railroads with less-extensive shops, SP could seriously consider manufacturing its own locomotives and cars, at least through most of the steam era. The company also wanted to retain its labor force and the skill it possessed. To do this in a constantly changing economy meant that the company had to constantly search for ways to utilize its men as effectively as possible. This often involved work *on* the shops as well as *in* them. Company forces performed any feasible construction work. For example, the renewal and expansion of the Blacksmith Shop walls in 1939-40 used in-house labor. That this was common, indeed the norm, is evident in a memo from one head of shops, who wrote, "Presume that you will wish to perform this work by Company forces."[200] Another example has a superintendent stating, ". . . with respect to enclosing hatchway, this work

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200 "Renew Blacksmith Shop," GM No. 7997, CSRM.

will be performed by Company forces."[201] As noted earlier, similar assumptions flavored decisions regarding the purchase or in-house manufacture of locomotives and cars. That the management could make such assumptions is a fine testament to the continuing dedication and skill of the shops' labor force.

Southern Pacific was equally adept at managing its use of the materials used to maintain the shop buildings. Just as each building individually exhibits the SP's conservation efforts, many of the "building blocks" used to construct and maintain them show evidence of the company's desire for economy through standardization and the use of readily available materials. Foundations provide one example. Redwood grillage below stone, brick, and rubble columns made up earliest foundations at the Sacramento complex. Redwood lumber was plentiful in the region, stone rubble was readily available, and clay for brick came from nearby mountains, so the company made maximum use of these local materials to support the interior columns, track work, and exterior walls. By the time renovations were necessary several decades later, concrete was available and economical, and older foundations could economically be replaced and strengthened as needed.

The brick walls used in most of the major structures serve as another example of the company's practicality. To begin with,

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[201] "Renewal of Elevator #13364 Car Shop No. 3, Sacramento Shops," GM No. 40614.

they were made from local clay and, thus, affordable during the shops' early years. The brick also proved to be durable, even during disasters. During the fire of 1898, one of these brick walls was all that separated the flames in the Planing Mill from the main Power House, containing a blaze that could have halted operations throughout the complex had the power source been damaged or destroyed. As the *Sacramento Bee* reported, ". . . the engine and boiler room was separated only by one dead wall of cast strength and thickness."[202] After the 1916 fire destroyed much of Car Shop No. 3, brick firewalls were included in the reconstruction to contain damage should another fire erupt.

While walls stood as signs of permanence, non-structural elements like windows and doors marked the continuing changes. Some were replaced because of age or damage, but many changes resulted from additions or renovations. The glass areas and sash materials, as well as the overall sizes and styles of the various windows reveal much about how and when these buildings were altered. Where the oldest walls of the Planing Mill have repeating round-arched windows, the newest concrete walls in the Blacksmith Shop display a facade of windows. Throughout the complex, door and window arches were filled in when operational changes made them unnecessary, and many that survived have been changed in type or size.

[202] "Fierce Fire at the Shops: Important Departments Suffer From This Morning's Blaze," *Sacramento Bee,* November 7, 1898, 8.

Roofs were a constant problem to some degree. They needed to withstand weather, yet also provide as much natural light and ventilation as possible. By 1870, roofs framed with "wrought iron and sheathed with corrugated sheet metal, with clear spans of up to 150 feet, were recommended for use by railroads and industry,"[203] but iron was in limited supply and expensive in Northern California when the first buildings were built. Consequently, the earliest buildings of the Sacramento Shops had wood-framed roofs. Iron was more readily available and affordable toward the end of the 19th century, so iron, and later steel, roof trusses became standard in most new construction by 1900. The most common roof sheeting was corrugated, galvanized iron. The zinc coating inhibited rust, at least for a while, and the corrugations stiffened the thin sheets. In another example of self-sufficiency, Sacramento's rolling mill produced most of the roof sheeting used for decades. The Blacksmith Shop, with its unusually harsh environment, was a rare exception. Its corroded iron was replaced with transite roofing that held up well. While this might seem to have been a good choice for other buildings, too, the added cost compared to the home-rolled iron caused the company to forego it elsewhere. Clerestories, necessary for ventilation and light, generated problems of their own that required frequent repair. As electric lighting was

[203] Bradley, 140.

installed throughout the shops, the need for clerestory windows lessened, and it was cheaper to board these windows up that to maintain them.[204] These roofing problems were by no means unique to the buildings at Sacramento; rather they were typical of those experienced with similar roofs on industrial buildings around the country. But SP did have one advantage. Since the company made its own corrugated iron sheeting, its maintenance costs were likely less than those of most owners of buildings having these roofs.

DESTRUCTION, CONSTRUCTION, AND MODIFICATION

The history of the Sacramento Shops was shaped by a variety of influences. Some factors affected the Sacramento site as a whole, where others targeted specific buildings. All buildings faced similar environmental, social, political, economical, and technological challenges that determined their growth, stasis, or decay, but certain structures housed operations that made them more susceptible to calamities like fire or corrosion.

In general terms, the environment was a major factor in determining the shops architectural change, with location, natural disaster, earthquakes, disease, and weather constantly

[204] *Ibid*, 142.

putting forth new challenges to shop upkeep. Events such as floods caused the company to fill in surrounding marshes and raise the level of the land to a safe elevation for the shops. In later years, the remaining marshes from the Sutter's Lake brought mosquitoes, with their irritation and disease, to the workers. This, along with a need for additional land to accommodate expansion, provided a reason to fill in the lake. When eucalyptus trees were thought to repel mosquitoes, along with the malaria they carried, the company planted over 2000 trees in 1876-77, a move that significantly altered the appearance of the site. Unfortunately, they proved to be ineffective and were later removed. As has been noted, building design was affected by the need to admit as much natural light as possible before electric lighting became commonplace.

Once built, however, the shop buildings endured a continuing battle against weather, wear, and the hazards endemic to heavy industrial shops. Even with constant cleaning, maintenance, and enforcement of safety rules, fire always remained a threat at the Sacramento Shops. Unpredictable and severely destructive, fire could quickly destroy costly supplies, equipment, patterns, and the structures themselves, not to mention the risk of personal injury to workers. Fire prevention played a large role in building design and construction. After each fire, SP's engineers and managers would learn new lessons and try to reconstruct with the latest fireproofing measures, including such things as firewalls, fireproof doors, and fireproof materials like reinforced concrete and transite. As detrimental as they were, fires forced changes and demanded reexaminations of shop practices and procedures.

The shops had their own fire system until the fire of 1898, which burned down the Car Machine Shop and Planing Mill. This fire made deficiencies in the system glaringly apparent. The shops had their own fire department, complete with inspectors, inspection guidelines, and fire-fighting equipment (inclusive of pumps and hoses). While this seemed to be appropriate, the 1898 fire revealed that it was woefully inadequate. The SP's water supply system had mud in its pumps, causing low water pressure and flow. Further, fittings on the city fire department's hoses did not match the threads on the SP's hydrants, making it difficult to bring all available resources to bear against the fire. With these complications, the City of Sacramento deemed it necessary to enhance the SP's private supply with a more reliable public water supply. Even though these measures were taken, the fire of 1916, which burned Car Shop No. 3, demonstrated that the water supply was still inadequate. The city worked with SP to replace the small pipes that could not handle the flow needed to fight large fires.[205]

[205] "SP Fire Laid to Careless Workman," 10.

Learning from these fires and disasters elsewhere, city and state officials developed building codes to regulate new construction and building maintenance. These not only guided new designs and construction methods, but also provided for the inspection of safety-critical elements such as fire-control devices, emergency exits, and elevators. Fire officials often suggested mastic pavements, transite roofing, or firewalls to minimize risk.[206] All of these measures helped ensure greater safety for each worker and building on the site. There were other minor incidents, but the 1916 fire was the last major fire at the shops.

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[206] "Renew Portable Electric Tool Outlets and Wiring in Passenger Car Shop," GM No. 32786.

PART III – OPERATIONS AND PRACTICES

WORKING AT THE SHOPS

"[I was] very, very happy with the railroad."[207]

Maintenance and construction of locomotives and rolling stock required a large assemblage of diversely skilled trades working under one roof.[208] Additionally, it required teamwork and close relationships between and within these trade divisions. Because of the complexity and diversity of equipment and tasks, and because locomotives and rolling stock were continually being adapted and improved, the work was never really automated, though it was eventually systematized and streamlined.

Shop jobs were good ones, at least when economic times were good for the railroad. Unfortunately, the economy was very dynamic, and employment at the shops varied with it, even though the company did what it could to keep workers busy. When the shops opened in 1863, the staff consisted of 15 men. By 1878, the shops employed 1,700 men, though employment fell to 1,300 by

[207] Carl Blakkolb interview, CSRM, 11.

[208] A union agreement of 1924 lists some of the trades represented in the shops: machinists, boilermakers, blacksmiths, sheet metal workers, electricians, shipyard mechanics, and carmen, which included patternmakers, upholsterers, painters, mill hands, cabinetmakers, platers and polishers, car cleaners, locomotive carpenters, and tendermen.

1883. By 1898, the staff had increased to nearly 3,000 men. During a recession in 1908, all employees were laid off, and the shops closed temporarily. They reopened and recalled employees shortly thereafter, but layoffs reduced their numbers once again in 1914, when the shops were running only six to seven days a month. By the next year, 2,000 men were working six days a week. Another wave of layoffs in late 1916 eliminated 200 to 250 jobs, but with the United States' entry into World War I, employment again climbed to 2,200 people, and the SP was desperate to hire more. By 1920, the shops employed 3,500 workers, but this number fell drastically during the Great Depression. During World War II, as many as 7,000 people worked three shifts, but this number fell to about 3,000 at its conclusion. With dieselization and the transfer of work to other, newer facilities, this number gradually declined until the shops closed in 1999.[209]

Unlike shops in some other parts of the country, virtually all employees at the Sacramento Shops were white men. Initially the shops employed mostly Scots, Irishmen, and Cornishmen, though by 1906 the city's work force also included Japanese, Mexicans, Italians, Jews, Yugoslavs, and Hindis. Nevertheless, native-born

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[209] Employment numbers were compiled from several sources, including *Nevada State Journal* (March 10, 1883): 480; *Sacramento Bee* (November 7, 1898): 8; *Sacramento Bee* (October 25, 1915); *Sacramento Bee* (October 19, 1916): 13; *Sacramento Bee* (August 28, 1917): 16; SP *Bulletin* (August 1920): 12; SP *Bulletin* (September 1947): 3; "Souvenir of Visit to Southern Pacific Railroad Shops and Stores at Sacramento, California," Office of Superintendent of Motive Power, Sacramento, 1952, 1; and David L. Joslyn, "Forty Six Years with the Southern Pacific," unpublished manuscript, 16.

whites came to dominate the shops' work force, which did not include large numbers of immigrants throughout

much of the 20th century.[210] The 1950s saw more Italians, Eastern Europeans and Russians employed, and by the 1960s Hispanics were represented.[211] Though as late as the 1960s it appeared that very few African-Americans or Asians worked at the shops, one early source mentions that the engine wiper was "usually a Chinaman,"[212] and during World War II the shops employed at least one all-black cleaning crew, and one former employee recalls a "black lady" who ran the turntable in the Roundhouse.[213] SP apparently recruited African-Americans in the South to work on the road, but those who joined the company were employed in Oakland, Los Angeles, and Portland rather than Sacramento. During World War II, Mexican nationals were imported to work on American railroads, and some of them worked in the Sacramento Shops during this period.

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210 While white males predominated, some historians suggest that, in general, there was a higher percentage of foreign-born employees in the shops than in the operating trades. See Shelton Stromquist, *A Generation of Boomers* (Chicago: University of Illinois Press, 1987), 189.

211 Information on workers, employment policies and working conditions was extracted from interviews with former employees prepared by the Sacramento Shops Oral History Project, CSRM. These employees were Seth Barry, John Benedetti, Cecil Bingaman, Carl Blakkolb, William O. Brown, Marvin A. Denowitz, Stanton C. Draper, Leroy Gabriel, Malcolm R. Gaddis, Jack Lenihan, Victor Ruiz, Ronald Rypinski, Edgar J. Seil, Howard Shrader, Robert Steffens, Rudy Telles, and Laura Walton.

212 *Nevada State Journal* (March 10, 1883): 480.

213 Laura Walton interview, CSRM.

Though workers in Sacramento did not appear to be as divided by ethnicity, language, or race as those in other work settings, minority workers did not appear able to rise in the hierarchy, perhaps because they were not taken on as apprentices. White workers denied any ethnic discrimination, but one Hispanic worker claims that he was passed over for promotion and received fair treatment only through the intervention of his union.[214] Nevertheless, the SP seems to have established a relatively nondiscriminatory work environment and in 1962, it became the first railroad to support John F. Kennedy's equal opportunity platform prior to passage of the Civil Rights Act.[215]

The first women employees at the Sacramento Shops were hired during the labor shortage of World War I, and they performed largely housekeeping activities like car cleaning and scrap sorting. Although many women left the shops (often after marrying other shop workers), some women remained on the payroll. These women apparently excelled at certain types of fine work in the pattern department and other shops where attention to detail was crucial.[216] One indication that they were considered equal

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214 Leroy Gabriel and Victor Ruiz interviews, CSRM.

215 Don L. Hofsommer, *Southern Pacific, 1901-1985* (College Station, TX: Texas A&M University Press, 1986), 252.

216 SP *Bulletin* (August 1920): 12-13.

to men is a 1921 union agreement, which states that women would receive the same pay rate as men for the same job.[217]

In addition to returning retirees and Mexican nationals, the shortage of labor during World War II caused the Sacramento Shops to hire hundreds of women, mostly from railroad families, and by the end of 1942 the shops employed nearly 2,000 of these "railroadettes."[218] Unlike the previous generation of female workers, however, these women could be found performing jobs as clerks, riveters, painters, locomotive cleaners, machinery operators, and drafters, occupations formerly restricted to men. Although it appeared that the quality of their work was high and they worked well with the other employees, the women disappeared rapidly from the shop floors when the previous workers returned from military service.[219] Almost all of the women who remained in the shops after 1945 were transferred to "pink collar" jobs as clerks or secretaries.[220]

Although the historical evidence is very clear that women who worked in the trades during the war were proud of their work,

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[217] Agreement between Southern Pacific Company and the Employees Represented by United Brotherhood of Maintenance of Way Employees and Railway Shop Laborers, effective December 16, 1921.

[218] SP *Bulletin* (January 1943): 20.

[219] Under union contracts men who left the shops for military service maintained their positions and seniority when they returned; most of the women in the crafts had less seniority than returning soldiers and were laid off after the war. Some women, however, continued in their jobs at lower levels.

[220] SP *Bulletin* (August 1920): 13. SP *Bulletin* (November 1942): 3-6. SP *Bulletin* (January 1943).

their skills, and their paychecks, it was often claimed after the war that "women never desired to secure those types of jobs."[221] One woman reported that a job she had applied for in the early 1950s "wasn't open to women," but that she was able to get the job after her husband, a railroad employee, intervened in her behalf. She also reported that, although she had mechanical experience from wartime work at a shipyard, at that time "they weren't taking women for mechanical at all."[222] Though women were not accepted as apprentices after the war, they again started working in heavy industry with the recognition of women's rights in the 1970s. Former employees recall seeing and working with women machinists and electricians during this period, and a photo of a female boilermaker apprentice even appeared in the SP *Bulletin*.[223]

Initially, the Sacramento Shops, like those of other West Coast railroads, offered opportunities for shop men unable to obtain promotion on the East Coast. After the turn of the century, however, most shop workers appear to have been hired locally and trained on site. It was typical for a man to obtain a position at the shops through a relative who worked there, often in the same craft as the old employee. In many families

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221 Robert Steffens interview, CSRM, 21.

222 Laura Walton interview, CSRM, 2.

223 SP *Bulletin* (July 1978): 3.

all of the men worked at the shops. This was partly the result of family members employed at the shops being aware of job openings, and recommending relatives to their superiors, but it was also due to the fact that SP was Sacramento's largest employer, so everyone in town had some connection to the railroad.

By the beginning of the 20th century almost all shop workers started as helpers or apprentices. The SP's first formal apprentice school, for boys aged 16 to 21, opened in Oakland in 1913. By 1925, a dozen or so more had opened, and nearly 1,000 apprentices had completed the program. The largest program was at the Sacramento Shops, with nearly a quarter of the 1,318 apprentices enrolled in 1925.[224] Seventy to eighty percent of apprentices that went through the program stayed with the railroad, a high number compared to other apprentice programs. Because of safety concerns and union regulations, apprentices didn't work with heavy equipment or work nights, nor did they receive holiday or sick pay.[225]

By the 1940s, the company was sponsoring a less formal helper apprentice program, in which employees worked for two years as craft helpers and then served three years as helper apprentices. Although the shops provided classroom training

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[224] SP *Bulletin* (May 1925).

[225] SP *Bulletin* (August 1920): 13. SP *Bulletin* (May 1925): 15.

during wartime for workers who would otherwise be attending school, the railroad no longer offered classroom training for apprentices. Many employees, however, furthered their education through the International Correspondence School in Scranton, Pennsylvania, which offered an extensive series of railroad courses, or through the University of California Extension Service.[226]

The railroad was willing to invest in education for employees, though by the late 1950s drafters and designers were mostly men with degrees in engineering. Some shop people were promoted into the management ranks, and the company often sent these people to college so that they could earn their degrees.[227] In 1963, the SP began a formal policy of reimbursing employees for study toward university degrees, and of providing free home-study courses, though several employees mentioned that the company had been doing this informally for at least a decade.

Training at the shops could also be provided informally. Former employees typically described their first days on the job as informal training. An employee could initiate training by asking questions or observing someone else's work. Additionally, shop employees sometimes increased their experience, skills, and knowledge by transferring to other jobs or shops.

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[226] SP *Bulletin* (January 1943): 5. Carolyn Dougherty conversation with Kyle Wyatt.

[227] William O. Brown interview, CSRM.

Before unionization of railroad employees, wages were flexible and subject to the influence of supply of and demand for particular skills. Railroads paid employees having desirable or scarce skills as much as it took to obtain their services, but during periods of slack work or depression the company cut wages or laid off employees as it saw fit. It is difficult to chart the actual rise and fall of earning power of railroad workers, because the cost of living, like the cost of everything the railroad purchased, fluctuated wildly during the last half of the 19th century due to war and depression.[228] Shop workers tended to make less than those in the operating trades, though skilled craftsmen and shop foremen made very good pay, especially in California where skilled labor was scarce.[229]

After unionization and the standardization required by the Federal Railroad Labor Board after World War I, wages and classifications became more formal and rigid. SP agreements with shop workers in the 1920s show employees segregated by craft, with each skill set described in detail, classified, and rated. Wages were set by agreement for Class A and Class B skilled

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[228] For example, the price of a 4-4-0 engine increased from $7,000 in 1874 to $9,000 in 1879, and to $13,500 in 1882. *Railway Age* 4 (May 15, 1879): 234. Ed Dybowski, "Notes," *Nevada State Journal* (January 10, 1882).

[229] General and comparative information on railroad labor is largely drawn from the following sources: James H. Ducker, *Men of the Steel Rails* (Lincoln, NE: University of Nebraska Press, 1983); Walter Licht, *Working for the Railroad* (Princeton: Princeton University Press, 1983); David Lightner, "Labor on the Illinois Central Railroad, 1852-1900", Ph.D. diss., Cornell

tradesmen, helpers, and apprentices.[230] Over the course of the 20th century railroad work became less and less lucrative compared to other jobs. According to one employee, SP employees were looked down upon during the 1940s, because the railroad was considered to be a low-paying employer.[231] By 1975, however, SP's wages and benefits had increased enough to be equivalent to those of other transportation modes.

At the turn of the century, shop workers were paid once a month in gold and silver coin when the pay car came to town. In order to reduce the chance that the car would be robbed, the pay train had no set schedule. Its arrival date was not fixed, but workers received a couple of days' notice. Debt was frowned upon, and workers' wages could be garnished for debts to local merchants. Frequent garnishment of wages could be cause for dismissal. The company began to pay workers with checks in 1905, a practice that posed some initial problems when workers found it difficult to cash the checks. One local department store, however, found it quite lucrative to cash railroad workers'

University, 1969; and Shelton Stromquist, *A Generation of Boomers* (Chicago: University of Illinois Press, 1987).

[230] Agreement between Southern Pacific Company and the Employees Represented by United Brotherhood of Maintenance of Way Employees and Railway Shop Laborers, effective December 16, 1921. Revised Agreement between Southern Pacific Company and the Employees in the Motive Power and Car Departments Represented by the Shop Crafts Protective League, effective June 1, 1923.

[231] Victor Ruiz interview, CSRM.

checks—usually selling them something at the same time—and other businesses soon followed.[232]

Before the widespread unionization of the 1880s, work rules tended to be flexible and somewhat arbitrary. Master mechanics had total authority over hiring, firing, and work assignment in the shops, and it was common for them to summarily suspend or dismiss employees for any infraction. After unionization, companies like SP acceded to workers' demands for more centralization and standardization in hiring, firing, work rules, and discipline. Unions fought for promotion and job assignments based on seniority rather than merit, because merit was often used capriciously and arbitrarily. Both unions and management saw benefits in the "Brown System" of discipline, named after George R. Brown, general superintendent of the Fall Brook Railway. Instead of levying suspension or dismissal for every infraction, which was hard on both the railway and employees, a "virtual suspension" was entered into an employee's record. These "brownie points" could be erased by subsequent months of good conduct. The system did not, however, prevent employees from being fired on the spot for truly serious offenses. This system also provided the unforeseen advantages of standardizing the procedure for dealing with particular situations and setting appropriate penalties for infractions.[233]

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232 Joslyn, "Forty Six Years."
233 Hofsummer, 113.

Although foundry work was often reported to be done "by contract" in 1891,[234] SP, unlike several other American railroads, apparently never tried to institute piecework at the Sacramento Shops. At various times, however, some shops, including the Blacksmith Shop, Brass Foundry, and Air Room, did have quotas for individual employees. Other shops, like Car Shop 9 and the Truck Shop, worked on an assembly line and had a daily quota of cars or components to complete. The Air Brake Shop, which also ran on an assembly line, reworked brake valves and cylinders using new parts purchased from Westinghouse and New York Air Brake companies, since reworked internal parts were not allowed in brake systems. But these were not typical operations. Much of the maintenance work depended on the condition of the locomotive, car, or component, and jobs generally took as long as they needed. Workers were not generally pressured to work quickly, though they were able and willing to do so when required by an emergency or other deadline. Around the middle of the century the Car Truck Shop turned out 20 trucks a day, though the workers could rework as many as 125 at maximum production. The schedule was set by demand from the car shop.[235]

By 1900, the shops were run strictly by union rules. Job assignments, overtime, and vacation schedules were assigned

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[234] John Alexander Hill, "Some Notes on the Southern Pacific and Central Pacific Shops," *The Locomotive Engineer* (July 1891): 132.

solely by seniority. When layoffs were necessary, senior employees "bumped" people with less seniority into lower-level jobs in the same craft. Employees were only permitted to work in their own crafts, something that occasionally caused problems at the shops. Carmen, boilermakers, electricians, machinists, and even laborers belonged to different unions, and each strenuously protected its exclusive right to perform all work in that craft. While this seems straightforward, conflicts could arise over "incidental work," which could be something as simple as changing a light bulb. The company and the unions followed a formal grievance procedure to resolve serious conflicts. Despite what might appear to be an unreasonable rigidity of these union rules, workers were generally positive about their unions, recognizing that they defended workers' interests, and that their wages and working conditions would be worse without union support.

Into the 1930s, shop employees generally worked six days a week, Monday through Saturday, though many men often got Saturday afternoons off as well as Sundays. Ten-hour days were typical. By the late 1930s, the shops generally ran two eight-hour shifts, though overtime might be necessary in emergencies, or to complete rush jobs. Conversely, hours were often reduced during the winter, or during other slack periods. During World War II the shops ran on two ten-hour shifts due to shortage of labor, though maintenance and a few other departments were staffed around the

[235] SP *Bulletin* (July 1961): 10.

clock. Employees recall that the shops, like many other shops and factories, were regulated by a steam whistle, which had its own boiler room, near the end of the Blacksmith Shop. It blew five minutes before each shift, at the beginning of the shift, at lunch time, and at the end of the shift.[236]

Working conditions varied considerably in the different shops. After the completion of Car Shop 9, most carmen worked outdoors or, at best, under its shed. When it rained, carmen brought and wore rain gear. In winter they burned scrap lumber and waste in empty paint and oil drums and spent as much time as they could huddling around the fires. In the summer, replacing wooden interiors inside steel boxcars sitting in the sun could be like working in an oven. Car Shop 3, by contrast, was heated, because the more-precise woodwork done there required a fairly constant temperature. Other interior spaces enjoyed heat from steam radiators or space heaters in the winter. Electric fans for cooling became common after electricity had been installed.

Not all interior workspaces offered better conditions than outside, however. The Foundry always was an unpleasant place to work—hot, dark, dirty, and poorly ventilated. The fine dust produced by the grinders in the Brass Shop was both unpleasant and unhealthy. The Erecting and Boiler shops were extremely noisy, with cranes, riveting, and pounding boilers. These

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[236] Howard Schrader interview, CSRM, 18.

conditions were similar to those found in other heavy industries of the time, and the workers generally found ways to cope, or even find advantages in their particular situations. One carman, for instance, mentioned that as miserable as Car Shop 9 was, at least it was not dusty like the Cabinet Shop.[237]

Contrary to what some people have believed, SP never had a policy that required employees to use the restrooms at specific times. No employee interviewed was familiar with this practice,[238] though it was may have been employed by foremen from time to time as a way to harass employees with whom they had some gripe.

While it did not go to any extreme, SP took some measures to make the shop environment as attractive as possible, since a good environment promoted employee health, safety, and morale. As noted earlier, the company planted eucalyptus trees around 1876 because it believed they reduced the risk of malaria. They turned out to be ineffective in that role, plus they presented a fire hazard, so SP chopped them down in 1906. Nevertheless, some green spaces remained on the shop grounds, including a few palm trees that were planted on the site (and still flourish south of the locomotive transfer table).[239] Typical practice was to

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[237] Seth Barry interview, CSRM.

[238] See Schrader interview, CSRM, 13, for an explanation of why this would not have been a practical policy.

[239] David L. Joslyn, "Sacramento General Shops," unpublished manuscript, 20, CSRM.

whitewash the interior walls of shops to make them as bright as possible. In the 1940s, the shops began to paint machines as well as walls in light colors, and moving machine parts were painted in bright contrasting colors to make them easier to see. Lines were painted on the floors to indicate storage areas, aisles, and machine clearances.[240]

The shops supplied some workers' tools, but workers bought or made others of their own. Union agreements required the company to provide clean, dry, sanitary workspaces, water and ice where necessary, safe equipment, and protective clothing. As goggles, hard hats and other safety equipment began to come into regular use, the railroad began to provide these items to the workers and require their use. Otherwise, employees supplied their own work clothes.[241] Each foreman held his own safety meetings, generally lasting about five minutes at the beginning of each shift. The Sacramento Shops appear to have had a good safety record throughout their history. From 1940 to 1942, the shops earned the top safety award for all Southern Pacific shops.[242]

Although railroads and other companies generally did not take responsibility for worker injuries or deaths until well into

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240 SP *Bulletin* (September 1944): 3-5.

241 SP *Bulletin* (August 1920): 13. SP *Bulletin* (February 1936): 16.

242 SP *Bulletin* (May 1940).

the 20th century, companies like SP often paid medical bills and portions of salaries, or made lump-sum payments to survivors, on a case-by-case basis. The SP did not appear to have a formal workers' compensation policy until mandated by state law in 1913, but it did employ injured workers as a "crippled class" in less physically demanding positions, such as road crossing guards.

In 1868, the CP made a pioneering investment in its employees' well being. The railroad built the CP (later SP) Hospital in Sacramento, the first industrial hospital in the world, to treat employees as well as passengers injured in railway accidents. This nonprofit institution was funded by employee contributions, company funds, and grants and gifts from several sources, which paid for all required staff, drugs, food, and supplies for the patients, as well as for 15 emergency facilities around the system. Several doctors saw patients at the Sacramento hospital during certain hours, but major surgery was later performed at another SP hospital in San Francisco.[243]

The first hospital, a four-story wood building located on the southwest corner of 13th and C streets,[244] accommodated 125 patients and also housed an employee library. Between 1868 and 1877, it served about 3,600 patients and accommodated about 7,750

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[243] Hofsummer, 113. SP *Bulletin* (April 1921): 3-6.

[244] The unmarked site is currently occupied by a single-story, vacant brick industrial building.

office visits. Of these, only 148 died.[245] By 1904, this hospital had been replaced by a brick building located just northeast of the current site of the California State Railroad Museum. The Hospital Department was reorganized in 1963, when the railroad started using private employee insurance and encouraging employees to use independent physicians and hospitals.[246] The building had become vacant by the 1970s and SP demolished it in 1986.

Shop workers were forced to retire at 70, at which time it was apparently traditional for fellow employees to provide a party and a gift—generally a watch, though a blacksmith once received an easy chair. In 1903, the SP created a Board of Pensions, and by 1922, the company was spending more than $500,000 a year on pensions for retired or disabled workers.[247]

The railroad instituted paid vacation for employees in 1942. Employees received one week of vacation until they had worked for the railroad for five years, when this was doubled. Vacation time increased incrementally after that, reaching a maximum of five weeks after 25 years of service. According to the rules,

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[245] "Central Pacific Railway," *Railway Age* (October 25, 1877): 1461. This number seems high, considering that between 1903 and 1913, only 74 Baldwin employees died out of about 15,000. The Baldwin statistic, however, is from a later period, and the SP hospital treated both shopmen and those in the more dangerous operating trades. On the Illinois Central Railroad during the 1880s, one in 36 machinery department workers was disabled, and one in 1,090 machinery department workers was killed (Lightner, 263). This accident rate was lower than that of the operating trades.

[246] SP *Bulletin* (November 1963): 7.

casual time off, including medical leave, was not compensated, but this rule apparently was extremely flexible, and foremen usually ignored casual time off if an employee did not abuse the privilege.

From the railroad's earliest days, it was apparently customary for the company to issue travel passes to employees. During the shops' early years, a laid-off employee could request a travel pass in order to seek work elsewhere as well. The scope of travel covered by the pass depended on an employee's service. Employees who had worked at the railroad for ten years received individual travel passes for the division only. Travel privileges for the employee and his family increased incrementally until employees with 25 years of service received family passes good system wide. The railroad also awarded several travel passes annually as a reward for meritorious service.[248] In addition to individual and family travel, SP occasionally provided excursion trains to Reno or the Sierras for groups of employees and their families.

The CP and SP avoided significant labor disputes until the serious national strike of 1894, and the railroad did not become a closed shop until 1952, but wages on the West Coast were relatively high and working conditions were good. Railway

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[247] Hofsommer, 111.

[248] *Sacramento Bee* (December 23, 1915): 15.

management was on good terms with the unions, particularly the brotherhoods representing the operating trades: engineers, firemen, conductors, and trainmen. The widespread strikes that affected many of the nation's railroads in the summer of 1877 were averted at the Central Pacific when management rescinded its decision to reduce wages by 10 percent. This was not always possible, however, and the CP, like other railroads, laid off both shop and railway workers, reduced hours, and later cut wages by 10 percent during a recession a few years later. Dissatisfied employees met to organize a work stoppage, though apparently no real strike took place.[249]

Shopmen's unions never became as powerful as the operating trades unions. None of the operating trade brotherhoods represented shop workers, and the first shopmen's unions—representing boilermakers, machinists, sheet metal workers, blacksmiths, carmen, and electricians—were not founded until the 1880s. In the absence of strong craft unions, shopmen, particularly Western shopmen, initially joined the Knights of Labor or unions affiliated with it—organizations that later affiliated with Eugene V. Debs' American Railway Union (ARU). The ARU was popular among SP employees, and the union organized its first California chapter in Los Angeles about six months before the Pullman boycott in June 1894. Several thousand SP

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[249] *Railway Age* (March 29, 1883): 19. *Railway Age* (June 14, 1883): 343. *Railway Age* (June 25, 1885): 408.

workers in Northern California soon belonged to some forty local ARU lodges.[250]

In June 1894, the ARU called for a nationwide boycott of trains that included Pullman cars. The "Big Four" brotherhoods were against the Pullman boycott, and loyalties were divided for those workers who belonged to both an operating brotherhood and the ARU. Members of the shop unions, however, did not share this conflict, and they largely supported the strike. About 2,180 ARU members, including more than two-thirds of the 3,000 Sacramento Shops workers, honored the boycott. Many merchants, local officials, and members of the community had grown to resent what they saw as monopolistic practices on SP's part, and they, too, supported the boycott. To them, "[t]he railroad was often considered a bigger threat than the ARU."[251]

The state militia was called in to force the men back to work at the shops and on the trains, but many of the local National Guard troops were also railway men and ARU members who sympathized with the strike. Thus, the militia did virtually nothing to stop the strike. Five hundred Federal troops were then called in from San Francisco, and they occupied Sacramento for two months, a month longer than any other city in the

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[250] Information on the Sacramento Shops during the Pullman strike was drawn from William W. Ray, "Crusade or Civil War? The Pullman Strike in California," *California History* 58, no. 1 (Spring 1979): 20-37.

[251] Ray, 32.

country. The initial community support declined as the strike dragged on, and especially after Debs and other ARU officials were arrested in mid-July. The first train finally left Sacramento on July 11, and within a month traffic was rolling again. The railroad fired and blacklisted many of the participants. With the strike broken, SP cut the wages of its unskilled workers, those the company felt it could easily replace, but it left the wage rates for skilled workers alone.

After this nationwide labor crisis, the Federal government attempted to mediate between railroad labor and management, passing laws like the Erdman Act of 1898 and the Railway Labor Act of 1926 that guaranteed more rights to unions and workers in exchange for strict injunctions against union actions to stop work or otherwise impede commerce. Worker unrest continued sporadically at the Sacramento Shops, though subsequent actions were relatively insignificant. The shops participated in a general strike in 1911, but the company hired replacements. On July 1, 1922, in a strike organized by the machinists' union, shop workers across the country walked out over a Federal decision to lower wages to 1920 rates. Most Sacramento Shops employees stayed on the job, and although the nationwide strike lasted several weeks, the Southern Pacific was shut down for only three days. The workers who stayed on the job received "recognition payments" from SP for their loyalty.[252]

Unlike many similar facilities, the Sacramento Shops were located near the center of an urban area, rather than in a suburban setting or an isolated "company town," though Sacramento had fewer than 50,000 residents in 1910.[253] In addition to the railroad and government, the city served farmers in the Central Valley, industries connected to the railroad, and industries like canneries that needed access to rail and water transport. Sacramento became the capital of California in 1854, and the capitol building was completed in 1869, but the railroad remained the largest employer in Sacramento until well into the 20th century. Although census information records occupation, but not employer, it appears that between the 1880s and the 1920s about 15 percent of Sacramento's workers toiled in the shops, though around 1900 this figure may have been as high as 25 percent.[254]

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[252] Hofsummer, 113. SP *Bulletin* (August 1922): 8.

[253] California Railroad Commission Engineering Department, "Case No. 1019: Subject: Investigation—Southern Pacific Passenger Depot at Sacramento," San Francisco, November 4, 1916, 1.

[254] George E. Waring, Jr., *Tenth Census of the United States, Report on the Social Statistics of Cities,* Part 2 (Washington, D.C.: GPO, 1887). Herbert Gutman theorizes that communities are sympathetic to strikers when the number of workers is below 10 percent because workers are well integrated into the community, and above about one third because workers' interests are significant to the community. With SP employing between 15 and 25 percent of its workers, Sacramento does not appear to fit this theory. Herbert G. Gutman, *Work, Culture and Society in Industrializing America* (New York: Vintage Books, 1977).

The leaders of the Central Pacific (except for Huntington, who preferred New York) moved with the railroad's headquarters to San Francisco in the 1870s, so railroad owners and managers had little direct effect on the politics of Sacramento. Though the local Chamber of Commerce cooperated with SP, and one of the city's newspapers, the *Record-Union*, was controlled by the railroad, no CP or SP official was involved at a high level in local government. Railroad workers had stronger roots in the community than did managers, and some of them were active in local politics. The railroad, and particularly the shops, had such a strong presence in the city that almost everyone had some connection with the business. Around the turn of the century, the leaders of both the Democratic machine and the progressive opposition had connections to the railroad. Edward James Caraghan owned a restaurant that catered to many SP employees, and Thomas Fox, an insurance executive, had worked in the shops as a rivet heater at age 16. Michael J. Burke, who was elected to serve on the city's board of trustees between 1900 and 1912, was a blacksmith at the shops.[255]

Former employees describe the social atmosphere at the shops as very pleasant, and the employees as a "good natured bunch,"[256]

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255 William E. Mahan, "Political Response to Urban Growth: Sacramento and Mayor Marshall R. Beard, 1863-1914," *California History* 69, no. 4 (Winter 1990/91): 354-371.

256 Edgar J. Seil interview, CSRM.

who enjoyed parties and socializing outside work hours. The SP Club on 15th Street hosted frequent social and athletic events. The shops sponsored an SP Band and Glee Club as well as various types of athletic teams.[257] In addition, shopmen associated with each other through Masonic organizations. Supervisors and workers alike participated in Masonic rites. Andrew Jackson Stevens was an active Mason, as was D. L. Joslyn. In Sacramento, as in other railroad towns, Masonry was very popular with railroaders of all types.[258]

In 1872, an observer found at the shops, "a host of busy and intelligent mechanics . . . all evidently happy and contented, and having an individual pride in the excellence of their work."[259] Subsequent oral histories and accounts of the shops make it clear that shop people generally took pride in their work and their personal accomplishments on the job. Workers may have experienced the Sacramento Shops positively for several reasons. Apprentices received regular raises, and other workers received yearly raises. The shops' career ladder was clear, and there were frequent opportunities for improvement and promotion. In *Working for the Railroad*, Walter Licht points out that "only a minority of railwaymen in the nineteenth century achieved the

[257] Frequent references to these appear in SP *Bulletin*.

[258] Aside from being mentioned in oral interviews and newspaper articles, Masonic affiliation was indicated by the symbol that appears in an 1876 portrait of the staff of Machine Shop No. 2.

[259] *Mining and Scientific Press* (February 20, 1872): 86.

benefits of homeownership,"[260] but when the *Sacramento Bee* reported on the city's decision to finance a larger water main to the shops, it noted that 90 percent of shop employees owned their own homes.[261]

Railroad workers enjoyed a degree of autonomy that was rare in other occupations. Whether out on the road running a train or maintaining track, or working in the vast shops complex, railroad workers did most of their work away from close supervision. The company expected them to know their jobs, obey the rules, and put in a full day's work without constant attention from their bosses. In the absence of constant supervision, workers exercised considerable autonomy, and they were often able to try out ideas for improvements to the shops or their specific jobs. The work was unusual and diverse, and most of the workers appreciated the responsibility the company trusted to them. Shopmen also took pride in the fact that they worked with some of the latest and most technologically advanced equipment available anywhere. Railroading was the technological wonder of the 19th century, and it remained a culturally important occupation well into the 20th. Being part of such an enterprise, not to mention the legends and lore that accompanied it, gave workers a sense of accomplishment, importance and identity.

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[260] Licht, 229.
[261] *Sacramento Bee* (November 8, 1898): 4.

REPAIR AND MAINTENANCE

The most typical type of work at the Sacramento Shops was the routine maintenance and repair of the railroad's locomotives and rolling stock. In the early days of railroading, engineers and engine crews performed inspections, cleaning, maintenance, and even made minor repairs to their engines in the roundhouse. By the end of the 1870s, however, engineering, maintenance, and the operating trades had become more narrowly defined, and engine crews no longer did locomotive maintenance work.[262] Shop workers became responsible for the cleaning, maintenance, running repairs and heavy repairs, both scheduled and nonscheduled, of all locomotives on the line.

This task was made challenging by the variety of engines the railroad operated. In its early days the Central Pacific was short of money and could usually afford to buy one engine at a time. Engines were generally chosen for their low cost rather than their performance characteristics. Not only were the railroad's engines from several different manufacturers, but engines from the same manufacturer were of different designs. By 1883, the Sacramento Shops was maintaining 480 locomotives of 48 different types from 15 different manufacturers.[263] To maintain

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[262] Stromquist, 105. Unionization and standardization among railroad companies facilitated this change in job tasks.

[263] *Nevada State Journal* (March 10, 1883).

such a collection, it was easier for the shop staff to fabricate new parts than to stock and catalog stores and spare parts for every type of engine.

In addition to required maintenance, workers frequently upgraded and improved engines sent in for maintenance and repair, replacing equipment and adding new accessories. Engines were constantly being fitted with new, improved, and sometimes experimental parts.[264] The first engine to be comprehensively rebuilt in this fashion at the Sacramento Shops was the CP 173, a Norris Lancaster 4-4-0. This engine had been built in 1864, and wrecked in 1868. A. J. Stevens, the shops' master mechanic, rebuilt this engine in November 1872, incorporating several modifications he had devised. They proved to be successful, and this engine became the model for the first ten locomotives built at the Sacramento Shops.[265]

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[264] See the "Modifications" section in Part I and the "Innovation and Invention" section in Part III for details of some of these experiments. Experimental designs often required training of the engineers who would have to run the altered locomotives as well as shop men who installed and maintained them. These sections describe some efforts by the shop master mechanic to train engineers in the use of new systems in the 1890s; however, this practice may not have been consistent as, for example, some of the inventions created and installed by Master Mechanic Andrew Jackson Stevens that were later removed from engines because the shop staff did not know how to adjust or maintain them.

[265] Diebert and Strapac, 45. Joslyn, "Forty Six Years," 31-32. This engine was also the model for Walt Disney's first 1/8-scale steam locomotive, *Lilly Belle* (see Michael Broggie, *Walt Disney's Railroad Story* (Pasadena, CA: Pentrex Media Group, 1997), 124-127). This engine's sister engine, CP 172, is often described as having received two extra driving wheels in the shops, however, this is a misreading of the photo in question, which is actually of the CP 72, a Danforth engine.
See above reference and Gerald Best, *Snowplow* (Berkeley: Howell-North Books, 1966), 30.

After the United States entered World War II, the pressing need for troop and supply mobility caused a huge demand for steam locomotive repair in the shops and more than 100 steam engines, some built as early as the turn of the century, were put back into service.[266] Less than a decade after the war, however, SP abandoned steam in favor of diesel motive power. In 1957, specialized steam support equipment began to be scrapped. The last recorded steam locomotive work in the shops was in 1969, when a steam engine was cosmetically converted into a replica of the CP's *Jupiter* for the 100th anniversary of the driving of the Golden Spike.[267] This engine, actually Virginia and Truckee 12, has since been restored to its original appearance and is now in the collection of the California State Railroad Museum.

American railroads started using diesel locomotives during the 1930s.[268] Aside from being a new and unfamiliar technology, diesel engines had some perceived disadvantages. Aside from initially costing more than steam engines, they required new fuels, parts, and maintenance techniques. They also required more precise technology to maintain, and people familiar with steam were concerned that diesels were not as specialized for

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266 SP *Bulletin* (September 1941): 14.

267 SP *Bulletin* (April 1969): 7.

268 See the "Dieselization: A Whole New System" section in Part I for the history of the Southern Pacific's adoption of diesel motive power.

different types of trains and lines.[269] This last issue was a particularly difficult one for motive power engineers and master mechanics, who necessarily designed every steam engine they bought or built to meet individualized performance criteria.

Though it took some time for people whose total experience base involved steam locomotives to realize it, diesel operations were fundamentally different than steam operations. Unlike steam engines with tractive-effort and horsepower curves that generally peaked above 20 miles per hour, diesels developed their greatest tractive effort when starting and at low speeds, meaning that they could start a heavier train than a steam engine of the same power and weight. All wheels of freight and switching diesels were driving wheels, so every pound of a unit's weight contributed to traction.[270] As much as one-third of a steam locomotive's total weight, not including its tender, was carried by its leading and trailing trucks—necessary for good tracking and a large firebox, but detrimental to traction. Diesels could be coupled together into multi-unit consists able to handle any train, with all of them under the control of one engine crew. Diesels stopped less often for refueling, and they had no need

[269] Diesel manufacturers apparently liked to claim that they would customize their locomotives, but they charged the railways extra for optional equipment, unlike steam engine manufacturers, to whom customization was routine. Author's conversation with Bill Farquhar, August 7, 2002.

[270] Most early passenger diesels rode on six-wheel trucks having unpowered center axles. These long-wheelbase trucks tracked very well at high speeds, but two traction motors per truck were sufficient to handle the power.

for water towers. Where steam engines generally required servicing every hundred miles or so, diesels could run the length of the railroad without a single engine change. Automatic wheel-slip control and, later, dynamic braking provided valuable train-handling tools that were impossible to install on steam locomotives. Engineers calculated that for every dollar expended in fuel for a steam locomotive a diesel would require only 43 cents, and there were additional savings in maintenance. When it was time to replace engines that had been running through the Depression and World War II, American railroads opted for diesels. Southern Pacific, however, was relatively slow to adopt diesel power. The road possessed some of the most modern steam locomotives on any railroad during the 1940s, but the diesel's performance and cost advantages were simply too great to ignore for very long. The decade-long conversion began in 1949, but SP still ran substantially more steam than diesel engines in 1952.[271]

With the new diesels came major changes at the shops. The first diesel maintenance equipment was installed at Sacramento in 1949, initiating major changes in the operations and layout of the shop facilities.[272] Part of the Erecting Shop was turned over to diesel repair, and Car Shop 3, formerly used to construct

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[271] SP operated 580 road steam engines vs. 230 road and 92 switching diesels. Joslyn, "Forty Six Years," 33.

passenger cars, became shops for repairing air brakes, governors and injectors. The manufacturer of the majority of SP's diesel engines, General Motors' Electro-Motive Division, assisted the company in laying out the new maintenance facilities.

The Sacramento Shops rebuilt its first diesel engine in 1956. Until the late 1960s diesels usually came in for major repairs only after they had failed, but in 1969, the SP began a General Rehabilitation and Improvement Program (GRIP), in which the Sacramento Shops completely overhauled diesel locomotives on a scheduled basis. GRIP involved much more than fixing specific failures. Locomotives were not simply repaired in-kind, but completely rebuilt and upgraded with modifications from EMD or based on recommendations from shop personnel. Electrical systems in particular benefited from numerous modifications that improved reliability and simplified maintenance. GRIP furnished the company with reliable, up-to-date power for approximately two-thirds the cost of new locomotives.[273] Thanks to the shops' expertise in overhauling locomotives, the SP was able to avoid purchasing new locomotives until 1984.

Despite the extensive alterations the Sacramento Shops underwent to accommodate diesel maintenance operations, most diesel work was gradually transferred to newer shops in Los

[272] See "Maintaining the New Technology" section in Part I for a description of this process.

[273] See Appendix II for a description of the GRIP rebuilding process.

Angeles, Roseville, Ogden, and Houston. In 1965, running maintenance and inspection of diesel locomotives was transferred to Roseville, but the Sacramento Shops continued to do heavy maintenance and locomotive rebuilding until they were closed, including a second GRIP between 1986 and 1989.

The Sacramento Shops were also responsible for maintaining and repairing the railroad's rolling stock. Freight cars were frequently damaged by careless loading and unloading, or by loads shifting in transit. They often needed walls and ends straightened, doors repaired, and wooden interiors or floors replaced. Car Shop No. 9, the open-air shed built around 1917, was initially the site of this freight car maintenance and renovation, though by 1930 it had been converted solely to freight car construction.[274]

As with locomotives, in addition to repair and maintenance the Sacramento Shops often modified and upgraded cars as they came in. George Westinghouse introduced the straight air brake in 1869, followed by the much-improved automatic air brake in 1872. The CP soon began to install them, long before the Federal Safety Appliance Act of 1893 required their use. The railroad installed these brakes first on passenger locomotives and cars, completely equipping them by 1876, and then on freight cars.[275]

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274 SP *Bulletin* (May 1917).

275 *Mining and Scientific Press* (February 1872). Author's conversation with Kyle Wyatt.

By the late 1930s the Sacramento Shops, as well as shops in El Paso and Los Angeles, were adding steel sheathing, improved air brakes, and power hand brakes to boxcars. Starting in 1963, the shops rebuilt many boxcars with wider doors to suit new loads. On occasion, cars were redesigned to perform different functions. A number of flatcars, for example, were converted to carry quarter-mile-long strings of welded rail.[276]

During the 1920s cars and cross-country buses began to compete with passenger rail trains for customers. During the late 1930s and early 1940s, the shops overhauled the passenger car fleet to improve safety and comfort, installing foam rubber seats, fluorescent lights, and air conditioning, plus hydraulic snubbers and rubber isolators to give a smoother, quieter ride. Private automobiles at that time lacked air conditioning, so air-conditioned passenger cars were a major incentive for customers to take the train. In 1932, the shops installed ice-activated air conditioning in fourteen dining cars. Ice, carried in bins beneath the floor, generated chilled water for cooling coils. Fans blew air across those coils and into the car. Between 1934 and 1936 SP installed this type of air conditioning in 165 coaches and other passenger cars. In addition to adding the air-conditioning equipment, many cars received 6-wheel trucks to

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[276] SP *Bulletin* (October 1936): 4. SP *Bulletin* (December 1949): 6-7. SP *Bulletin* (May 1957): 18. SP *Bulletin* (October 1963): 6-7. SP *Bulletin* (April 1968): 6-7.

carry the extra weight, and un-needed roof vents were removed. The more advanced Waukesha mechanical air-conditioning system was introduced in passenger cars beginning in 1937. The shops hired new workers to add air-conditioning systems, as well as to modernize older passenger cars, with some coaches being rebuilt into lounge, club, observation, and coffee-shop cars to serve more-demanding travelers.[277]

During World War II, passenger travel increased, but train travel began a steady decline after the war as competition from cars and airlines increased. In the late 1950s, prewar passenger rolling stock was comprehensively inventoried, and either scrapped or restored. Because fewer people now traveled in sleeping cars, many of them were remodeled into other types of cars. The Sacramento shops converted sleepers and other little-used cars into new configurations, including seventeen automat cars with vending machines that served pre-packaged food and beverages 24 hours a day. These cars apparently were a hit with the Sacramento Shops staff,[278] but they fared less well with the traveling public. Amtrak discontinued automat service when it adopted SP's passenger routes in 1971. The automat cars may not have been popular, but dome cars, including some unique three-

[277] SP *Bulletin* (February 1935): 6. SP *Bulletin* (October 1935): 10-11. SP *Bulletin* (December 1935): 6. SP *Bulletin* (March 1936): 3. SP *Bulletin* (September 1940): 9. SP *Bulletin* (November 1940): 7. SP *Bulletin* (April 1946): 4.

[278] SP *Bulletin* (July 1962): 26. SP *Bulletin* (September/October 1963): 12.

quarter-length dome cars the shops rebuilt from other cars for service on the *City of San Francisco*, were a success. The first test run of one of these dome cars was in 1954, and the shops built ten in all.[279]

After Amtrak was formed in 1971, Southern Pacific retained responsibility for its San Jose-San Francisco commuter line, though this was subsequently transferred to the state. SP also furnished, under contract, train crews and running maintenance for the passenger trains Amtrak continued to run on SP lines. The road also contracted with Amtrak to do some repair and upgrade work, but by and large no more passenger cars were maintained at the Sacramento Shops. In 1980, the equipment and staff that performed freight car repair and maintenance work for the division moved from Car Shop No. 9 to the rehabilitated Pacific Fruit Express shop in Roseville, essentially ending car work at Sacramento.[280]

NEW EQUIPMENT CONSTRUCTION

Maintenance and repair of locomotives and rolling stock was the principal function of the Sacramento Shops, but the shops'

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[279] Dennis Ryan and Joseph W. Shine, *Southern Pacific Passenger Trains* (La Mirada, CA: Four Ways West Publications, 2000), vol. 2, 334-339.

[280] SP *Bulletin* (September/October 1980).

skilled craftsmen also had the opportunity to design and construct locomotives, rolling stock, other equipment for the railroad, and even do some commissioned work for other clients.

The Central Pacific's first engine, the *Governor Stanford*, was purchased in 1862 from Richard Norris and Son in Philadelphia. Although most of the steam locomotives used by Southern Pacific were built on the East Coast by Cooke, Rogers, Schenectady, Baldwin, and other manufacturers, the Sacramento Shops were capable of constructing locomotives of a quality equal to any of these builders. The shops manufactured steam locomotives during two periods, between 1873 and 1889 and between 1917 and 1937.[281]

The railroad undertook the design and construction of locomotives at the shops for several reasons. The additional work kept skilled craftsmen, difficult to replace if laid off, busy during slack periods. During boom times, when the general demand for new engines was high, busy locomotive manufacturers generally requested cash up front, something SP could rarely afford, and the manufacturers' backlogs often made railroads wait for engines just when they most needed the additional motive power. And although a number of railway master mechanics had suggested the creation of standard specifications for locomotives by the mid 1860s, many of them, including Sacramento's Andrew

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281 Railroad management's debate over whether to construct or purchase

Jackson Stevens, were always eager for the chance to build locomotives of their own design.

Before SP's management agreed to commit resources to building engines, shop workers had demonstrated that they were capable of doing the work. In addition to rebuilding CP 173, as described above, the shop workers showed their mastery of heavy forging technique by successfully fabricating a 6.5-ton wrought iron main shaft for the bay steamer *El Capitan* from scrap iron.[282] The Sacramento Shops started its career in locomotive construction in 1873 with the design and construction of twelve new 4-4-0 locomotives modeled after CP 173. These engines were built almost entirely from local and reclaimed material, including iron from used horseshoes that had arrived in Sacramento as ship ballast, and parts and materials salvaged from scrapped engines; the only purchased parts were steel castings from San Francisco and steel tires from the East Coast.[283] Almost all of these engines remained in service past the turn of the century; one of them, Virginia and Truckee 18, *Dayton*, still survives at the Nevada State Railroad Museum in Carson City.

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locomotives is discussed in the "Manufacturing" section in Part I.

282 "Iron Work at Sacramento," *Mining and Scientific Press* 25, no. 25 (December 21, 1872): 394.

283 Information about SP locomotives came largely from Timothy S. Diebert and Joseph A. Strapac, *Southern Pacific Company Steam Locomotive Compendium* (Huntington Beach, CA: Shade Tree Books, 1987), and "19th Century Locomotives Built in the Southern Pacific Shops in Sacramento" and "20th Century Locomotives Built in the Southern Pacific Shops in Sacramento", unpublished manuscripts, CSRM.

In 1881-82, the shops constructed seven 2-6-2T tank engines designed by A. J. Stevens for a suburban commuter line in Oakland. These engines were used on the Seventh Street corridor until it was electrified in 1911-12; some of them were later upgraded with steel cabs and acetylene headlights and used as switch engines. One of them, CP 233, still exists, at the California State Railroad Museum in Sacramento. During this same period Stevens also designed and built a 4-8-0 locomotive, CP 2nd 229, the world's largest until Stevens' next creation.

In 1884 the shops completed CP 237, *El Gobernador*, designed to pull heavy loads over the Sierra Nevada.[284] This engine, which set a new size record, was the last SP locomotive to be given a name as well as an identification number, and was the first new engine to include Stevens' patented valve gear. This 4-10-0 locomotive weighed 154,000 pounds, and it could theoretically pull almost 600 tons up the 2.5-percent Tehachapi grade. It was so heavy that it was kept in Sacramento for nearly a year. When it finally left, it was disassembled and carried on flat cars for fear that it would damage bridges. *El Gobernador* proved to be a white elephant. Its boiler was too small to generate enough steam for its enormous cylinders. It soon returned to the shops for redesign, but that never happened, and

[284] *Recent Locomotives* (Novato, CA: Newton K. Gregg, 1972 reprint).

it was finally scrapped in 1894. For Stevens, it was a rare failure.

Between 1884 and 1889 the shops built several locomotives of three different types, all of which included the Stevens valve gear and other characteristic Stevens engine design elements. Several of the 4-6-0s built during this period initially burned wood, but they were converted to coal or oil later. A photo of one of these engines, CP 177, shows an ornate locomotive with a teak cab. Some of these engines ended their lives in Oregon, with the last one going to scrap in 1927. The shops also constructed additional 4-4-0 and 2-8-0 engines. The 2-8-0s were something of an experiment for Stevens, who had believed that two-wheel lead trucks caused excessive wear on the lead drive wheels. It proved not to be a problem.

Only one new locomotive[285] was built at the Sacramento Shops between Stevens' death in 1888 and 1917, although several received major rebuilds that made them into essentially new engines. As World War I came to an end, the SP, desperate for motive power, but dissatisfied with the standard locomotives that had been designed by the United States Railroad Administration, began again to design and manufacture locomotives in-house, building 123 between 1917 and 1937. These engines were not the innovative machines of Stevens' day, but were generally modeled

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[285] Kyle Wyatt believes that this engine, CP 2nd 10, built in October 1889, was designed by Stevens' successor, Henry J. Small.

after engines the SP had purchased earlier, and the creators of these engines were not Sacramento Shop mechanics but designers based in San Francisco.

The first of these engines, the M-6 2-6-0s and the P-3 4-6-2s, were built using spare parts from outdated Harriman-era designs that happened to be on hand. These engines were of several types: 4-6-0 Ten-Wheelers, 2-8-0 Consolidations, 0-6-0 and 0-8-0 switchers, 4-4-2 Atlantics, 4-6-2 Pacifics, and 4-8-2 Mountains. The Mountains were the largest locomotives ever built at the Sacramento Shops, and they became SP's premier passenger power until the introduction of the new, streamlined GS-2 4-8-4 Golden States in 1937.

The eight Class SE-4 0-8-0 switch engines, SP 1307-1314, built between 1930 and 1937, were the last locomotives built in Sacramento. Considered to be new locomotives, they utilized new cast-steel engine beds (frame and cylinders integrated into one casting), but their boilers were salvaged from retired 4-4-2 Atlantic locomotives. The last of these locomotives was scrapped in 1960.[286]

The Central Pacific and Southern Pacific railroads carried an unusual diversity of types of freight, eventually consisting of nearly equal percentages of agricultural products, finished goods, forest products and mining materials, as well as

[286] "20th Century Locomotives Built in the Southern Pacific Shops in Sacramento."

merchandise and animal products, including livestock. Such diverse cargoes required many types of freight cars, and the SP became a pioneer in the design of modifications and adaptations to transport different kinds of freight by rail. Although the railroad generally bought freight and passenger cars from East Coast builders, the Sacramento Shops built many freight cars and a few passenger cars.

By the 1930s, Car Shop No. 9 had been converted from a freight car repair area to a freight car construction shop that employed a system of "unit construction" modeled after automobile assembly lines. At one end of a half-mile track, wheels and trucks from the Car Machine Shop were assembled. The car in process was then pulled along to the following stations:

- Body bolster and steel draft sills
- Wood sills, framing, flooring
- Superstructure, siding, linings
- Trimmings, ladders, doors
- Roofing
- Spray painting
- Lettering
- Weighing
- Stenciling
- Inspection

Using this system Car Shop No. 9 could turn out a car every 50 minutes, or about ten cars a day (a damaged or wrecked car, by contrast, could take up to two months to repair); nearly three times more cars were built per year than were built in the late 1910s. The unit system was also safer for employees, as materials did not need to be lifted over workers' heads and workers were not required to climb the cars.[287]

Car Shop No. 9 was being used and improved at least through the 1950s, and the shops built more than 10,000 freight cars between the middle of 1905 and the end of 1954. The shops built 1,500 automobile cars between 1950 and 1951, along with 1,000 gondolas and 2,000 boxcars.[288] By the early 1940s, however, construction of complicated rolling stock like refrigerator cars was being phased out at the Sacramento Shops, and Car Shop No. 9 finally ceased operation in 1980, when all car construction was transferred to Roseville.

The Sacramento Shops constructed its first passenger cars, 24 first-class passenger coaches, in 1874. At that time a passenger coach took two weeks to build, and an additional two weeks to paint, varnish and finish. Though most of the railroad's passenger cars were ordered from Pullman and other car builders, Car Shop No. 3 turned out several passenger cars in the

[287] SP *Bulletin* (October 1936): 4-5.

[288] SP *Bulletin* (November 1954): 13.

1870s and 1880s, as well as business cars—private cars for top railway officials. The most ornate of these was the *Stanford,* built for Southern Pacific President Leland Stanford, in 1883. The luxurious car contained a parlor, dining room, bedrooms, a porter's room, and a kitchen, all finished in rosewood and mahogany.[289]

Around the turn of the century railroads began to use steel instead of wood passenger and freight cars, to address safety concerns for passengers and employees and to meet United States Postal Service regulations protecting the mail from fire and collision. In 1906 the Sacramento Shops built the first experimental, steel-bodied passenger car, with a frame constructed in the Boiler Shop instead of the car shop. This car had an arched roof, an interior finished with mahogany, electric lights, and steam heat. Later passenger cars included no wood at all, though steel surfaces were sometimes painted in faux mahogany finish. The shops constructed its first all-steel postal car in 1907 and an all-steel coach the next year. Though the Sacramento Shops pioneered these designs, subsequent new steel cars were ordered from Pullman and other manufacturers. The shops constructed the last new wood passenger car in 1905, though SP continued to buy wooden passenger cars through 1910. After 1911, the road purchased all-steel cars exclusively for passenger

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[289] *National Car-Builder (*May 1880): 79. *Scientific Press* (February 1872). SP *Bulletin (*July 1919): 9. SP *Bulletin* (February 1922): 4-8.

service, and within two years almost one-third of its passenger fleet was steel.[290]

In addition to passenger cars and freight cars, the shops built several other types of rolling stock including baggage cars, mail cars and cabooses.

The shops also built rolling stock for the other companies owned or controlled by the Southern Pacific. The shops built 160 cable cars for the Market Street Cable Railway in San Francisco between 1882 and 1888; most of these were "Combination Grip and Passenger Cars, San Francisco Pattern," although some were open cars. Apparently two of these cars still exist, though they were altered from open cars to California Avenue-style double-ended cars in 1907. Market Street Railway Sacramento-Clay cable car No. 17 is stored in the Smithsonian Museum, and No. 19 is part of the San Francisco Municipal Railway's historical collection.

The shops also constructed 20 passenger coaches for San Francisco's Park and Ocean Railroad in 1882. In 1902, most of these cars were sold to the Pacific Electric Railway in Los Angeles, where they were used until the late 1920's, with the last one being scrapped in 1947. Additionally, the Sacramento Shops designed and built cars for the San Francisco Steam Railway, and may also have built horsecars for San Francisco

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[290] SP *Bulletin* (June 1921): 13-14.

streetcar lines and the Market Street Railway in Oakland as early as the 1870s.[291]

TOOLS, EQUIPMENT, AND PUBLIC WORKS

"Nothing was impossible for the SP."[292]

In addition to constructing locomotives and rolling stock, the Sacramento Shops turned out and maintained an array of railroad machinery for the Southern Pacific. In 1920, 45 percent of the equipment in service on the Southern Pacific's Pacific Division had been manufactured in Sacramento. Shop staff designed and built most of the tools, equipment, and machines at the shops, including all of the equipment used in the foundry.[293] By the early 1960s, however, a former tool room worker found that the tool room had deteriorated because the railroad was buying tools rather than making them at the shops.[294]

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291 SP *Bulletin* (April 1919): 13. SP *Bulletin* (July 1919): 9. Joslyn, "Sacramento Shops," 26 and 31. *Sacramento County Historical Society Golden Notes* 19, no. 4 (November 1973): 4. Additional information on local transit cars comes from Don Holmgrendon of the San Francisco Cable Car Museum.

292 Howard Shrader interview, CSRM, 20.

293 SP *Bulletin* (August 1920): 12.

294 Laura Walton interview, CSRM.

The Sacramento Shops were involved in the creation of various devices to clear the track through the Sierras of snow during the winter.[295] The shops installed pilot plows on locomotives operating on these lines. Between 1866 and 1884, they constructed ten "bucker" plows. These wood and iron vehicles, designed by George Allan Stoddard and constructed by the carmen under Master Car Builder Benjamin Welch, weighed as much as 19 tons and rode on two trucks. As many as eleven steam locomotives would push a bucker plow at fairly high speed toward snowdrifts, relying on its shape and momentum to clear a path. It was a dangerous but reasonably effective way to clear snow off the tracks. Coordinating that many locomotives using only whistle signals was difficult at best, and both plows and locomotives frequently derailed when they encountered ice, though it was usually possible to ease them back to the rails along the grooves the flanges had cut in the ice. Another device tried was the headlight plow, which covered the entire front end of specially modified locomotives. As with a bucker plow, additional locomotives would help by pushing it.

The road began experimenting with steam-powered snowplows in the late 1880s. One of the early designs was the Cyclone snowplow. The company bought one, despite the fact that it had performed poorly during tests. The shop staff reduced the

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[295] Most information on snow removal and fire protection can be found in Best, *Snowplow*.

Cyclone’s cylinder size, and increased its boiler capacity in an attempt to improve its performance, but it was still unsuccessful under Sierra conditions. The SP had intended to purchase ten more, but the additional machines were never purchased and the original snowplow was dismantled in 1894. Henry J. Small, superintendent of motive power at the time, liked the basic design of the Cyclone, and he and T. W. Heitzelman patented a supposedly improved version that they called the Pacific Snow Excavator in 1891. A prototype constructed in the Sacramento Shops in 1890 failed miserably, and it, like the Cyclone, was also soon scrapped.

The most effective design proved to be the rotary snowplow, which featured a large impeller covering its front face. This impeller, turned by a steam engine, dug into the snow and threw it far to the side of the track. The operator controlled the wheel’s speed, and he could reverse its direction to throw snow to either side of the track. The rotary plow had its own locomotive-type boiler to provide steam for the impeller’s engine and, like other plow designs, needed several locomotives to push it. The SP purchased its first rotary snowplow from Cooke in 1887, but it saw no use for two years because of mild winters. It saw hard use during the winter of 1889-90, however, and afterward was sent to the Sacramento Shops for repairs to the blades and installation of a new boiler. Finding them to be the best answer to the Sierra’s deep drifts, the SP soon purchased two more rotary plows. In 1937 the railroad bought the two largest rotary snowplows in the world from the American Locomotive Company. Twenty years later, the Sacramento Shops began converting them from steam to electric power, using four standard locomotive traction motors in place of the steam engine and boiler. An adjacent locomotive furnished the electricity, and the traction motors could be removed and used elsewhere during the summer. Some of these rotary plows still run when needed to clear heavy snowfalls.

The lines through the Sierras and Cascades were challenging to keep open during the winter, but they could also be dangerous in the summer. Fire became the main hazard during the dry season. To protect the wooden snow sheds over the tracks, as well as to put out lineside fires started by sparks from engines, Sacramento Shops modified four locomotives to serve with fire trains in 1870. The shops installed steam-powered water pumps on the boilers of the *Governor Stanford*, the *Grey Eagle*, the *Unicorn*, and the *Niagara*. Later they added water nozzles on each side of the headlights in addition the two-inch hoses, and they modified additional locomotives for fire service, including switchers to protect terminal areas. The shops also fitted water sprinklers under the tenders of locomotives on these lines to keep the sparks created by cast-iron brake shoes from igniting brush around the tracks. (Composition shoes on modern equipment have reduced this risk.) At least as early as the 1890s, the shops constructed some fire cars equipped with water tanks, pumps, and hoses to supplement the fire-service locomotives. Since diesel locomotives did not have tenders with large water tanks, self-contained fire cars, usually converted tank cars, assumed the job during the 1950s. When needed, diesel locomotives hauled them to any location on the system.

In addition to machinery for the railroad itself, the Sacramento Shops were known for the large and complex machinery they created for the railroad's steamship companies. In 1872 the Foundry and Machine Shop fabricated a wrought iron main shaft for the railroad's steamboat *El Capitan*. This shaft was 28 feet long, 11 to 14 inches in diameter, and weighed 6.5 tons. It was fashioned entirely from scrap that the Foundry heated and hammered into the basic shape, which the Machine Shop then finished, at half the cost of buying the piece from the East Coast. In 1879, the shops built the machinery for the river steamers *Modoc* and *Apache*, and later for about 17 more steamboats of various types. In 1922, the shops constructed a gigantic walking-beam casting, 23 feet long and weighing 15 tons, for the San Francisco paddlewheel ferryboat *Newark*.[296]

In addition to the manufacture of machinery and components, the Sacramento Shops also fabricated structural metalwork. As

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[296] "Iron Work at Sacramento," *Mining and Scientific Press* 25, no. 25 (December 21, 1872): 394. SP *Bulletin* (February 1922): 4-8. SP *Bulletin* (July 1922): 7. SP *Bulletin* (January 1923): 25.

early as 1867, the first CP shops were making truss rods for bridges. A century later the SP's Sacramento Shops fabricated three emergency spans in only three days during December 1964 to repair a washed-out bridge at Noisy Creek, Oregon.[297] The shops also built desks, tables and chairs, cast-iron stoves, hand trucks, clipboards, dining-car silver serving pieces, and even moustache curlers.[298] The Sheet Metal Shop turned out step stools, buckets, garbage cans, and drinking fountains, among other things. The Foundry turned out all types of castings for railroad machinery and structures, including, in 1925, a ballast crusher for Santa Ana that weighed 23 tons, a record for the shops.[299] In 1930 the Foundry cast the bronze elements for the memorial to Theodore Judah which now stands at the corner of Second and L streets in Sacramento. This statue, designed by J. A. MacQuarrie of San Francisco and paid for by the donations of thousands of SP employees, honored the original surveyor of the Central Pacific Railway. It was cast in the brass foundry by Joseph Blasofsel, the only man in the shops with the skill and background to make such a casting.[300]

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[297] Hill, 132; SP *Bulletin* (January/February 1965): 7.

[298] Neill C. Wilson and Frank J. Taylor, *Southern Pacific* (McGraw Hill, New York, 1952), 226.

[299] SP *Bulletin* (August 1925): 11.

[300] SP *Bulletin* (November 1930): 15.

The shops also occasionally turned out work for other clients. In 1877 the City of Sacramento commissioned the Sacramento Shops to build a new pump for its waterworks, which remained in use until 1903. George Allan Stoddard and A. J. Stevens, who requested that Leland Stanford allow the city to pay for the pump in installments, designed this pump.[301] The shops also built equipment for the Empire Mine in Nevada. During World War II the shops manufactured six "hot-metal cars" for Kaiser in Fontana, California, and Sheffield Steel in Houston, Texas. These cars carried molten steel in large pots. Without them, the metal would have to have been poured into "pigs," allowed to cool, transported, and then reheated before it could be cast.[302] In 1942, the Sacramento Shops also supplied steel-plate bending rollers to Kaiser in Portland, Oregon, for use in building Liberty Ships.[303]

MANAGING THE SHOPS

The work within the Back Shop complex is not easily divorced from the day-to-day management of the locomotives, and master

[301] "To the Scrap Pile Goes the Old Stevens Pump," *Sacramento Record-Union* (April 2, 1903).

[302] SP *Bulletin* (December 1943): 6.

[303] SP *Bulletin* (September 1942): 3. SP *Bulletin* (November 1944): 23.

mechanics and superintendents kept careful watch over operating engineers and the locomotives themselves in order to minimize operating and repair costs. The master mechanic of the late 1800s oversaw both road operations and repairs, allowing him to view directly the effects of one on the other. Inefficient day-to-day route operations were felt directly in the shops and in the company's reduced profit. Time spent "in shops" repairing damaged parts or truing flat wheels caused by careless operation was time locomotives were not hauling income-producing freight or passengers, not to mention the shop and labor costs. Management, particularly the master mechanic, was acutely aware of the cost savings that could be found through efficient and safe operation of its locomotives, and they actively pursued those gains. Close records were kept of fuel, water, and sand expended on runs; wear and breakage of parts; and the performance of new tools, components, and materials. Master mechanics held locomotive engineers accountable for the proper and efficient operation of each engine, and queried the engineers when any aberrations occurred.[304] To ensure smooth operations, master mechanics also arranged for periodic engine crew training. One typical example is seen in a bulletin Heintzelman issued in 1896 announcing that, "while the Atlantic System Air Brake Instructor Car is at this point it is expected that all Engineers, Firemen, and Air Brake

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[304] Heintzelman to J. O. Marshall, August 15, 1899, MS 10, CSRM.

inspectors will avail themselves of the opportunity for receiving instructions."[305]

As part of its operations management, SP developed an extensive system of tracking repairs and modifications to its systems' locomotive stock. Heavy repair processes were reported on standard forms, with totals compiled monthly. For each SP locomotive moving through the Sacramento Shops, gang foremen kept maintenance cards that traced all maintenance and modifications to that engine. Such detailed record keeping allowed the master mechanic to investigate potential causes of a boiler explosion in 1896, for example. Heintzelman detailed the maintenance history of locomotive number 1904 as,

> Built in Sacramento Shops and went into service in August '88.
> Material used for construction, Juniata steel. The back head, throat sheet, dome sheet and firebox sheet were made of Juniata flange steel. The outside sheets of firebox and shell were made of Juniata shell steel.
>
> The record of repairs on this boiler is a follows:
> Jan 89 had 4 washout plug holes put in back head.
> Jan 90 tested at 180 Hydro. pressure: no repairs.
> April 90 tested at 180 Hydro. pressure: no repairs.
> July 91 tested at 180 Hydro pressure: 9 staybolts replaced and ash pan repaired.

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[305] Heintzelman, Bulletin, 10 March 1896, MS 10, CSRM. Southern Pacific was similar to other railroads in its use of modern cost accounting methods and management structures. As Alfred Chandler has discussed, the New York and Erie and the Pennsylvania Railroad pioneered the early management practices, adding layers of responsibility and cost accounting by the 1870s. It is not clear when these accounting methods were introduced at SP, but master mechanic letter books indicate that an extensive system was in place by the 1890s. Alfred D. Chandler, Jr., *The Railroads: The Nation's First Big Business* (N.J.: Harcourt, Brace, and World, 1965).

> Jan 18, 92 tested at 180 Hydro pressure: 5 staybolts replaced and 10 crown bar bolt nuts replaced.
> Oct 11, 92 tested at 170 hydro pressure: 10 staybolts renewed.
> May 23rd 93 tested at 170 hydro pressure 12 staybolts renewed.
> Oct 12th 93 tested at 170 hydro pressure 20 staybolts renewed.
> Mch 7th, 1894 tested at 170 hydro pressure: 5 staybolts renewed, 7 nuts renewed on crown bar bolts.
> 29 Aug 95 tested at 170 hydro pressure, 18 staybolts renewed, 49 nuts renewed on crown bar bolts.
> 22 Sept 95 sent to Shasta Division and returned to Sacramento.
>
> 20 Jan 96 It was then changed from a wood burner to a coal burner and sent to the Coast Division January 11th '96, remaining there until the explosion occurred.[306]

Managers also compiled reports of the total locomotives in the shops waiting for repair, in the round house, or that had been condemned. On September 21, 1895, for example, 22 locomotives were "in shops," four were "in round house," four were "completed," 14 were "unserviceable and laid aside," and five were "condemned." In the mid 1890s, 20 to 30 locomotives typically were in the shops for repairs at any given time.[307]

Even with such a system in place, management constantly admonished engineers and foremen to submit forms and reports in a timely manner. While it is not clear that there was any sort of organized resistance by the engineers to this bureaucratic imposition, letters from the master mechanics to locomotive

[306] MM to C. C. Bonte, Chief Clerk Shops, June 25, 1898, MS 10, CSRM.

[307] See "Report of Engines in Shop and Awaiting Repairs, Master Mechanic (Pacific System), letters and reports, 1894-1906, box 3, MS 10, CSRM.

operators imploring them to return reports of coal, water, and sand expended are common throughout master mechanic letter books. The master mechanic circulated a blanket rebuke to engineers in 1897, harping,

> A continual source of complaint is coming into my office in regard to engineers not leaving coal tickets at their terminals, showing amount of coal consumed on trips. This is a very important feature connected with our TONNAGE RATING SYSTEM [emphasis in original] now in practice and I hope you will be very punctual in complying with the rules governing this matter in the future.[308]

Master mechanics kept track of mileage per ton of coal, requesting explanations from engineers if their expenditures seemed particularly high. In other cases, the master mechanic requested explanations for extra sand and water usage. Such record keeping allowed management to target particular engineers that were careless in the running or upkeep of their locomotive.[309]

Information culled from standard reports also allowed master mechanics to pinpoint particular areas of waste, giving management specific ideas on where to focus technological development. Fuel expenditures proved a constant concern as oil prices rose, and SP would devote millions of dollars to fuel saving technologies, such as more efficient engines and appliances. Water was another concern, since certain regions

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308 Heintzelman to Engineers, August 28, 1897, MS 10, CSRM.

309 H. H. to J. B. Wright, Division Superintendent, 27 April 1895. H. H. to Engr. Fisbie, Willows, CA, April 29, 1895.

where the SP ran lacked good water supplies, driving the company to introduce water saving devices or better methods for increasing supply.[310]

Just as SP tried new locomotive materials and components, the company continually sought new machinery or other production-related materials to improve quality or reduce costs at Sacramento. SP's furnace men suggested replacing quartz rock with pulverized quartz rock or sand in the Hammer Shop and rolling mill furnace beds as "we can make a cleaner and better quality of iron for our axles and all finish work."[311] And in 1897, the master mechanic requested the purchase of a 51-inch boring and turning mill, "for making packing rings of all sizes, turning and boring eccentrics and straps, driving boxes and pulleys and all other classes of work . . . as no doubt a good percentage of saving could be effected over the present method of doing this work in a lathe."[312] In September 1899, Heintzelman queried the Rocklin, California, shop foreman as to the performance of their Boiler Washing and Test Apparatus (Rue Manufacturing Company), requesting, "I wish you would kindly give me your report as to its service in regard to boiler washing with hot water and, also, how you like it for testing boilers; and

310 See Richard J. Orsi, "Railroads and Water in the Arid Far West: The Southern Pacific Company as a Pioneer Water Developer," *California History* (Spring 1991): 46-61.

311 Heintzelman to H. J. Small, March 2, 1895, MS 10, CSRM.

312 MM to H. J. Small, December 22, 1897, MS 10, CSRM.

from what experience you have had with it would you recommend the purchase of any more."[313]

Similarly, SP continually looked to electrify the Sacramento Shops. H. J. Small apparently embraced the oft-reported efficiencies of electric motive power. Through 1897 and 1898, Heintzelman and Small repeatedly reintroduced proposals to electrically power portions of the shops.[314] In October 1898, Heintzelman proposed the purchase of "a few small tools" for the tool room, along with a 3-horsepower, 3-phase induction motor to power them. He commented, "the question of placing tools in our tool room, you know, has been discussed many times, but the question of applying power would always bear against us."[315] Small issued instructions requesting at least a minimum level of motive power change to electricity, compiling a list of motors needed, including one 75-, two 50-, one 15-, two 5- and one 3-horsepower, 3-phase induction motors.[316] And in late 1897 Heintzelman carefully compiled costs of current configurations

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313 MM to Rufus Maker, Foreman, Rocklin, CA, September 29, 1899, MS 10, CSRM. After hearing from Foreman Maker, Heintzelman responded to Superintendent of Motive Power H.J. Small (who must have originated the inquiry) that "There is no question but what it has been a great help to us during the rush of business, and also, for testing boilers." MM to H. J. Small, October 3, 1899, MS 10, CSRM.

314 Heintzelman refers to the fact that some electric motors had been installed as of December 1897. MM to H. J. Small, 22 December 1897, MS 10, CSRM. And in October 1898 a *Railway Age* journalist reported that "an unobtrusive electric dynamo" operated the shop machinery. "Notes along the Southern Pacific Line," *The Railway Age* (October 14, 1898): 749.

315 MM To H. J. Small, October 26, 1898, MS 10, CSRM.

and potential savings, reporting on these figures to Small. In regard to replacing manpower with electricity on the turntable, he priced out the required improvements at $600 and concluded that an electric motor had the potential of reducing costs by 75 percent. This could not be done immediately, however, because the electric company cut off power between 1 a.m. and 5 a.m.[317] Unfortunately, it is not clear when the company finally switched all facilities over to electric power.[318] Like many companies, SP maintained older machinery and power processes while introducing new ones, continuing to utilize belt-driven machinery up to World War II, for example, but with electricity driving the line shafts instead of steam.[319]

In trying new production and repair machinery, SP was attempting to cut costs where it could, as the repair, modification, and building processes did not lend themselves to an assembly-line procedure. Even after electric motors were introduced, shop machinery remained grouped by type. This is not to say that management failed to consider and reconsider machinery arrangement. Master Mechanic Heintzelman, in arguing

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316 H. H. to H. J. Small, November 12, 1897, MS 10, CSRM.

317 H. H. to H. J. Small, December 4, 1897, MS 10, CSRM. Also see H. H. to F. W. Mahl, December 4, 1897, MS 10 and MM to H. J. Small, January 31, 1898, MS 10, CSRM. Problems with intermittent power plagued the shops and in February 1901 it was reported that lack of power shut down all machinery for 28 minutes. H. H. to H. J. Small, February 16, 1901, MS 10, CSRM.

318 A letter suggesting that loss of electric power shut down "all machine work" suggests that most equipment operated by electricity by 1901. Joslyn places the transition at 1910, when the Corliss steam engine was no longer in use. D. L. Joslyn, "Romance of the Railroads," 27.

for the purchase of a parts cleaning tank, explained his plan for Erecting and Machine shop operations:

> I hope you can see your way clear to provide us with at least one tank, to be located at, or near, the north end of Machine Shop with a view to have all engines that go into Machine Shop, for general repairs, stripped at that point, assigning the work to our man who looks after engine truck work at the end of the shop; he to attend to delivering the parts of the engine to the cleaning tank, and from there to their respective places in Machine Shop.[320]

Locomotive maintenance, repair, and manufacture operated concurrently in the Sacramento Shops, creating the dust and din that marked 19th century industrialization. Scores of craftsmen plied their trades here as they replaced staybolts, trued wheels, assessed waste and damage, made and installed new components, instituted better practices, and brought forth whole new engines. By 1900 the Sacramento Shops employed upwards of 2,000 people to keep the Pacific System's locomotives moving.

Patterns of production, management, and modes of working with steam locomotive manufacturers and suppliers were well established by the turn of the century, even though variations would occur to suit unique situations. Methods of reporting might change (and likely increase), or machinery location might be altered, but the fundamental structure was in place. SP and the Sacramento Shops would grow dramatically over the next several decades, but management added to existing facilities and

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319 Cecil Bingaman interview, CSRM, 8.
320 Heintzelman to H. J. Small, February 21, 1896, MS 10, CSRM.

structures for the most part, altering the organization little until the mid-20th century.

SHOP PRACTICES

". . . although the Drawing Room has always been looked upon as a sort of useless place . . . it is a pretty good place to get ideas started."[321]

Until the turn of the century work in the shops was done almost entirely without what modern engineers would consider necessary specification and control documents. "Mechanical drafting to produce detailed plans would seem integral to any heavy engineering work, but many nineteenth-century machine builders felt otherwise."[322] At that time the drafter's job was basically to assemble and organize part drawings, and to supply foundry foremen with drawings and pattern numbers for the castings required by machinists. In 1878 the Baldwin Locomotive Works only employed 16 drafters to produce more than 500 engines of more than 50 different types.[323]

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321 Joslyn, "Forty Six Years": 32.

322 John K. Brown and Samuel M. Vauclain, "Comments on the System and Shop Practices of the Baldwin Locomotive Works," *Railway History Bulletin* 173 (Autumn 1995): 102-141, 135.

323 John K. Brown, *The Baldwin Locomotive Works, 1831-1915* (Baltimore: Johns Hopkins University Press, 1995), 85.

Instead of complete sets of plans, Baldwin and other machine shops used a "card system" of standardized components, drawn on cards (durable enough to last in the shop environment) at full scale. Machinists crafted these components by measuring the full scale drawings to produce the piece required. It was not until the 1880s, when the widespread use of blueprinting allowed multiple copies of drawings to be widely distributed, that the manufacturing system of preparing complete scale drawings began to be generally used. By the turn of the century this design and drawing method had been generally adopted. The card system or "ABC Process" was considered inefficient as "[t]he time saved in the drawing office is lost many times over in the shops."[324] The SP may have been an early adopter of the use of complete sets of scale drawings, as an SP representative gave a talk on this subject at a professional meeting in 1910. By this time the SP drawing office was using common standards and forms for engineering drawings, noting,

> There are many who refuse to be bound by [common standards], and these will declare that their use bars progress and trammels inventive genius. Such, however, is not the case and their adoption and maintenance, where good judgment is used, are highly beneficial from an economical standpoint.[325]

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324 Thomas A. Pudan, "An Ideal Drawing Office," *Proceedings of the Pacific Coast Railway Club* 3, no. 8 (December 21, 1910): 281-291, 287.

325 Pudan, 289.

The size, location, and staffing of drawing rooms at the Sacramento Shops changed with the status of drawing and design. The first formal offices were located in an annex just north of the northernmost varnish room of the Paint Shop in 1873. These housed the general master mechanic, master car builder, master mechanic, general foreman, chief clerk of shops and the Drawing Room. In 1888, some offices were moved to the lower floor of the Car Shop, though before that the mechanical offices had been moved to a building attached to the west side of the Erecting Shop. An observer in 1891 noted several offices and drawing rooms on the shop site.

A separate three-story office building was erected south of the locomotive transfer table in 1905. On the first floor were offices for the chief clerk of the shops, clerks for the master mechanic and master car repairer, master mechanic, chief clerk for the superintendent of motive power, superintendent of motive power, and the superintendent of shops, as well as the Telegraph Office and File Room. The second floor contained accounting and stores, the division storekeeper, an emergency hospital and a nurse’s room. The third floor held the office of the chief clerk, the Drafting Room, Laboratory, and Blueprint Room. (Photos show blueprints hanging out of the windows to develop in the sun.) The low-ceilinged fourth floor of this building, called the Sky Room, was used for safety meetings and other gatherings.[326]

The administrative offices of the railroad had moved from downtown Sacramento to San Francisco in 1873. By about 1910, design and administration functions moved from the shops to San Francisco, and the remaining Sacramento offices were left to oversee shop work.[327] By the late 1950s, though, the Sacramento Shops drawing room was helping to design and lay out machinery for other division shops and railroad plants, and did industrial engineering for the divisions. Louie Oberkamp, the Sacramento shop superintendent, employed a "genius gang" of longtime shop employees who did design/build work for the divisions that was considered better than that of engineering school graduates.[328]

SELF-SUFFICIENCY

"There was hardly a thing you could think of that couldn't be done there."[329]

When the Central Pacific set up shop in Sacramento in 1863, it was almost impossible to obtain equipment and supplies. Not

326 Hill, 133. Joslyn, "Sacramento General Shops," 23, 29-33. *Scientific Press* 86 (February 1872).

327 SP *Bulletin* (July 5, 1910): 3.

328 Stanton C. Draper interview, CSRM, 42-43.

only was it difficult and time consuming to send freight around Cape Horn, it was also dangerous and expensive to ship during wartime. With relatively little manufacturing infrastructure existing in California, the only alternative was for the railroad to make what it needed in its own shops. Thus, in the decades following the Civil War, the Sacramento Shops added a variety of facilities that enabled it to manufacture everything from locomotives to dining car service pieces. Over the years, Sacramento did a great deal more manufacturing than typical for most railroad shops.

The Sacramento Shops had their own compressed air, acetylene gas, oxygen, and water systems. Acetylene was produced on-site using the carbide process. Buildings were heated from a central boiler and steam distribution system, and power was supplied by steam engines through an elaborate line shaft and belt system. At some point after the shops began to purchase electricity from the Sacramento Electric Power and Light Company in the 1890s, the central steam engines gave way to large electric motors. Gradually, individual electric motors began to replace the shaft-and-belt drives, but the complete conversion took decades.[330]

In 1876 George Allen Stoddard designed and built the first experimental rolling mill at the Sacramento Shops, which was installed in the south end of the Blacksmith Shop. It was such a

[329] Marvin A. Denowitz interview, 21.
[330] SP *Bulletin* (February 1922): 28.

success that an additional set of rollers was installed in 1879. The Rolling Mill was moved into its own building by 1888, when two more mills were built. To supply the Rolling Mill, scrap iron was gathered up, wired together, heated in a furnace, and steam-hammered into billets. After reheating, these billets were fed into the Rolling Mill, where they were rolled into round, plate, and bar stock for the shops, along with angle, channel, and I-beam shapes. The Blacksmith Shop used much of this stock to make a variety of smaller products, including track bolts, nuts, spikes, tie plates, and dozens of parts for locomotives and cars. In 1890 the mills turned out 12,000 tons of iron, but this grew to an average yearly output of 17,000 tons by 1909. The price and quality of commercial iron and steel products and shapes improved to the point that the Rolling Mill could no longer compete by 1930, so the shops closed the operation. The building remained vacant until renovated as additional space for the Motive Power Department in 1940.[331]

It was occasionally assumed that everything on the railroad was made in the Sacramento Shops. One wag commented that, "The doughnuts [on the Bay ferries] were things of wonder, and customers had an often-voiced opinion that they came from the

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[331] *Railroad Age Gazette* 46, no.4 (January 22, 1909): 170.

foundry of the Sacramento Shops."[332] This apparently did not, however, keep them from being consumed in large numbers.

Obtaining raw materials on the West Coast remained a challenge well into the 20th century, and the railroad became known for its reclamation and recycling abilities. During both World War I and World War II, the company received praise for its extensive and systematic recycling efforts. The shops' Stores Department sent scrap trains out along the lines from Sacramento every two or three months, collecting thousands of tons of scrap. Back at the shops, the trains were unloaded with an electro-magnet, with the contents piled into a gigantic scrap heap to the northwest of the main shop complex, where it was sorted and sent to the appropriate shops. Where possible, items were reused directly, in original or modified form. Track tools, for instance, were cleaned and repaired as needed and returned to the Storehouse. Scrap iron was mixed with limestone, ferro-silicone, ferro-manganese and other elements, melted down, and recast. Steel rail was not recycled, but some old rail heads were rolled flat and made into components such as brake beams for freight cars. Used journal-box packing material was cleaned of oil and reused whenever possible, rubber hoses were reclaimed for less-stressful service, and workers recovered zinc from old batteries. These efforts continued after World War II, but they were

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[332] Wilson and Taylor, 197.

eliminated as part of the reorganization of the shops in the late 1950s. SP continued to save metal, oil, and paper, but it became more economical to sell the reclaimed materials to commercial recyclers. There were, however, instances where the shops did specialized recycling, such as modifying old flatcars for use as prefabricated bridges or ramps.[333]

STREAMLINING AND RATIONALIZATION

Throughout the 19th century it was difficult to standardize shop practice because SP operated so many different kinds of equipment. By the turn of the century, however, SP had devised a system that provided more accurate, standardized records of expenses and begun to get useful information that management could use to select better equipment and methods. The standardization problem became worse for a while when the road became one of the Harriman Lines (along with UP, the Illinois Central, and, later, Central of Georgia) around the turn of the century, and management was centralized in San Francisco and New York. The enormous increase in the number of lines and types of equipment forced consideration of new management techniques, some

[333] *Railway Age* (October 14, 1898): 749. SP *Bulletin* (April 1919): 6. SP *Bulletin* (November 1923): 17-19. SP *Bulletin* (April 1942): 3-7. SP *Bulletin* (December 1942): 2-3. SP *Bulletin* (January 1943): 2. SP *Bulletin* (December 1981): 8-9.

based on military models. During this period the title master mechanic was discontinued, the administration was reorganized, and clearer lines of communication and authority were established. Using an expanded version of SP's records system, shop workers and engineers on all of the Harriman roads began keeping more careful and detailed records of engine repairs and the use of consumables like fuel, water, and sand. The object was economy through large-scale standardization of equipment design and operation. For the next several decades, the locomotives and cars of all Harriman roads took on a decidedly family resemblance, even though the individual roads still maintained limited individuality to suit their unique conditions.

Streamlining and rationalization efforts during this period, like those during dieselization and reorganization in the 1950s and 1960s, required the shops to adopt new management and work practices. These changes, however, took place on a site largely designed in the 1860s, a fact that limited the options. Although plans from 1904 and 1906 show proposed new layouts, the railroad never redesigned the shop site, and it rarely tore down buildings, preferring to rebuild them—as little as possible—to accommodate new practices. Even after the fires of 1898 and 1916, the damaged buildings were rebuilt to the same footprints. With plenty of room to expand, the shops built new facilities, such as Car Shop No. 9, rather than demolish older ones, when no existing building could accommodate a new process or the increased volume.

The Sacramento Shops are what Stewart Brand would describe as "low road" buildings, "too hot in the summer, too cold in the winter, Spartan in [their] amenities, often dirty, and implacably ugly."[334] Low Road buildings foster creativity because occupants have total freedom to alter them to suit their needs. Evidence that such alterations were common is amply visible in the remaining shop buildings.[335]

INNOVATION AND INVENTION

"How intelligent mechanics can overcome natural disadvantage"[336]

Over the course of their history the Sacramento Shops successfully performed their principal function, maintaining and repairing railroad equipment. That they also created new equipment, adapted to changing circumstances and technologies, and invented new machines and methods is due to the skill,

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[334] Stewart Brand, *How Buildings Learn* (New York: Penguin Books, 1994), 27.

[335] See the section describing each building for descriptions of the ad-hoc alterations still visible in the buildings.

[336] *Nevada State Journal* (March 10, 1883).

talents, effort and creativity of the men who worked in the shops over the years.

Craftsmen like Benjamin Welch, the Central Pacific's first master car builder, invented the bucker snowplow and designed the road's first immigrant car to provide inexpensive transportation for settlers.[337] Stephen Uren, foreman of the Blacksmith Shop, obtained eight patents between 1870 and 1900 for devices to recycle scrap iron and manufacture nuts, brake shoes, links, spikes, and slotted bolts.

Others started in the crafts, but contributed to the development of the shops through their design and analytical skills. George Allen Stoddard, the shops' first draftsman and the Central Pacific's first official photographer, designed and constructed a rolling mill, two wheel foundries, and an innovative steam-powered locomotive transfer table.[338] After graduating from the University of California in 1877, Howard Stillman began work with the CP as an apprentice machinist and worked his way up to become engineer of tests in San Francisco.[339]

Still others contributed to the shops as managers. Henry J. Small, superintendent of motive power and machinery at the

[337] Joslyn, "Romance of the Railroads," 28.

[338] Joslyn, "Romance of the Railroads," 28. *Engineering News* 62, no. 3 (July 5, 1909): 67-68. *Railroad Age Gazette* 47, no. 7 (August 3, 1909): 270.

[339] Joslyn, "Sacramento General Shops," 31.

Sacramento Shops between 1888 and 1902, promoted standardization and efficiency, reducing the number of standard patterns from 550 to 44.[340] In the 1890s, he designed standard boilers for use in rebuilt locomotives, designed tests for wheels and other equipment, and introduced compound engines in an early effort to reduce fuel consumption through increased efficiency. Small was also the advocate who finally converted the shops from steam to electrical power.[341]

The man who perhaps most affected the style of the shops, and who exercised craft skill, design flair, and enlightened management, was Andrew Jackson Stevens, general master mechanic between 1870 and his death in 1888.[342] Stevens was "not so glamorous, perhaps, as the highly touted Big Four, but infinitely more useful."[343] Born in Vermont in 1833, he appears to have had no formal training as an engineer, starting his apprenticeship in 1850 as a machinist at the Northern Railroad in Concord, New Hampshire. He later worked at the Vermont Central Railroad and was an engineer as well as machinist and shop foreman on the Chicago, Burlington & Quincy Railroad in Aurora, Illinois, the

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[340] *Railway Age* (October 14, 1895): 747.

[341] Hill, 132-134.

[342] Biographical information about Andrew Jackson Stevens comes largely from the following sources: John Gardner, "A Biography Cast in Bronze," *Sacramento Bee* (July 31, 1943): M12. David L. Joslyn, "Andrew Jackson Stevens," unpublished manuscript, May 15, 1958, CSRM.

[343] Lloyd Bruno, "Looking Backward," *Suttertown News* (April 15-22, 1983): 10.

same railroad where A. N. Towne, later second vice president of the CP, was a conductor.

Moving to California in 1861, Stevens worked at the Market Street Steam Railway in San Francisco, the San Francisco and Alameda Railroad, and the San Francisco-Oakland Railroad. He also worked at the Vulcan Iron Works with his brother C. W. Stevens, who designed steam engines for West Coast railroads. He started work at the CP in 1869, and was soon appointed to replace Superintendent of Motive Power and Machinery Perkins, who returned to the East Coast. For unknown reasons, Stevens' title was general master mechanic instead of superintendent.

Stevens was soon able to persuade railroad management, which by then included his friend and colleague, General Manager A. N. Towne, to accept his plan to turn the shops into a locomotive and marine engine construction facility.

> When Mr. Stevens urged that locomotives could be turned out at the Sacramento Shops for less than their cost in the East he found little encouragement among the managers of the road . . . Mr. Stevens met every objection and his persistency at last induced his superiors to give his proposition a trial . . . To Stevens, more than to any other man, Sacramento owes the existence of the great and growing railroad shops within her limits."[344]

Master mechanics, positioned between railroad operations and locomotive manufacturers, were in the best position to identify areas of improvement and create design innovations. Stevens argued that locomotives designed for the East Coast were not

[344] *Sacramento Bee* (February 11, 1888).

suited to West Coast conditions, which included scarce and expensive fuel, unusually long hauls, uneven track, steep grades, alkaline water, fire hazards, and the need to lubricate valves on long uphill grades where it was impossible to throttle back the steam flow periodically to allow firemen to add tallow to the valve chest. He also argued, as did many mechanics of the time, that each locomotive should be designed for the unique conditions under which it would serve—passenger, freight, or switching—and the different combinations of loads, speeds, and line conditions each service presented.

Stevens' designs for new locomotives and improvements to locomotives the railroad had purchased from other manufacturers attempted to address some of these issues. Two of his inventions allowed deposits to settle out of boiler water (in either a tube across the top of the boiler or a dome on top of it) where they could be easily removed before they entered the boiler. One also worked as a primitive feedwater heater. A version of this invention appeared on a Schenectady-built 4-4-0 in 1880. The device, which Stevens referred to as a "boiler economizer" or "mud drum," was not as effective as he had hoped, and it was removed from several engines after Stevens' death.

Stevens patented three improvements in boilers and fireboxes intended to increase the heat exchange in the boiler and use fuel more efficiently, as well as to prevent the cracking of flues that could occur from a rapid change in temperature. One of Stevens' boiler patents included a "breather box" in the center of the boiler. Stevens' patent drawing shows this feature in a marine boiler, and it appears to have been used in at least one locomotive built in at Sacramento, although the records are not definite.[345]

Stevens later patented a device that allowed hotter and more even burning of oil in a firebox. Earlier, he had designed a firebox that extended around the locomotive's rear axle to allow a shorter rigid wheelbase able to negotiate sharper curves. He also favored radially stayed fireboxes. (Henry J. Small, Stevens' conservative successor, returned to more conventional crown-bar fireboxes and lengthened wheelbases. In Small's defense, however, track conditions had improved by his time, and he considered maneuverability less important than stability at running speeds.)

Stevens' inventiveness was legendary. "When there is a particular demand it is explained to him with the request that some appliance be perfected to meet the case. So far as the Gazette reporter is aware this request has never been made in vain."[346] Many of these appliances were patented; Stevens obtained 23 between 1861 and 1887. His first patent, filed while

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[345] A similar design appeared in a boiler design patented by J. Millholland in 1852, though there were some differences between it and Stevens' device.

[346] *Nevada State Journal* (March 10, 1883).

he was working at the CB&Q, was for a balanced slide valve, an idea he continued to refine, and for which he applied for six additional patents. One of the later patents for this valve allows for it to be lubricated when the throttle was closed on a downgrade, a vital feature for CP's long Sierra grades.

Stevens championed, and later designed equipment for, the SP ferry that crossed the Sacramento River between Benicia and Port Costa, arguing that building and operating a ferry was cheaper than building a bridge. The ferry had two paddlewheels driven by separate steam engines, giving it excellent maneuverability. The first ferry, the 420-foot *Solano*, went into service in 1879. A second, slightly larger, ferry, the *Contra Costa*, joined the *Solano* in 1914. These ferries conveyed SP trains across the river until the Martinez-Benicia Bridge opened in 1930. From his experience with steamboats, Stevens designed a power steering mechanism for ships that used a differential drum powered by a small motor. Two additional patents on this device showed a more complex and sensitive design later in the year and an improved brake/damper for it in 1881.

Stevens also patented a steam hoist for coal and freight, and a substantial number were constructed and used in shops throughout the system. (The California State Railroad Museum now has the pieces for one of these cranes as later modified to use compressed air.) Some of his other inventions included a steam-driven rotating plow on an agricultural machine like a combine that incorporated a seeder and harrow. D. L. Joslyn lists several other inventions that Stevens apparently didn't patent—equalized steam brakes for locomotives, steam operated fire engines for cities, a rail curving machine, a deep-well pump, a brick making machine, and an improved switch and switch stand.

Stevens' best-known invention at the time was a complicated locomotive valve gear that actuated separate intake and exhaust valves on each cylinder. Stevens obtained his first patent for this device in 1883, and he patented a refinement of the mechanism two years later. By his death, about sixty engines had been equipped with this type of valve gear.[347] According to Joslyn, the Stevens valve gear never became a success because mechanics found the unfamiliar mechanism difficult to adjust, and it was installed only on engines built or rebuilt in Sacramento during Stevens' lifetime. At other shops during Stevens' lifetime, and at the Sacramento Shops after his death, Stephenson, Walschaert, and, later, Baker valve gears predominated. After Stevens' patent had expired, however, his valve gear may have been installed on an Oregon Short Line engine in 1904, and an uncorroborated news story in 1943 indicated that it found some use on other locomotives as well.[348]

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[347] "Numerical Index to Drawings, Sacramento Shops," CSRM.

[348] "1943 Locomotives Carry Stevens Valve Gear," *Sacramento Bee* (July 31, 1943): M-12.

Stevens tested his inventions and shared the results, writing letters to trade journals and creating and distributing indicator diagrams that described the performance of his new and rebuilt engines. According to Kyle Wyatt of the California State Railroad Museum, Stevens was not only an innovator himself, his enthusiasm and interest helped to create an environment for experimentation and innovation. A series of four letters during 1887 and 1888 from the engineer of *El Gobernador* to another party about his efforts to operate this engine showed that, although the machine was a design failure, the engineer delighted in the intercourse between himself and Stevens, trying different ways to achieve acceptable performance. Upon Stevens' death, the engineer lost interest in the project and requested transfer to another engine.[349]

Aside from his genius and inventiveness, his staff honored him for his respect for working men. Stevens did not permit work on Sunday or blacklisting, and he fought the managers of the railroad to prevent layoffs and wage cuts. In 1877, other railroads were experiencing labor unrest because they cut wages, but Stevens encouraged management to cut hours instead, and SP avoided a strike. When he died in 1888, he was mourned by more than 2,000 people marching in the streets of Sacramento. In a rare display of worker respect for a boss, shop workers raised $5,000 to erect a statue of Stevens, sculpted and cast in San

[349] Conversation with Kyle Wyatt.

Francisco, which still stands in Cesar Chavez Park. A speaker at the statue's dedication ceremony stated, "For the first time in the history of the world the people of a city are gathered together for the purpose of witnessing the unveiling, by mechanics, of the statue of a mechanic."[350]

After World War II the Sacramento Shops continued to produce innovations in rolling stock design. In 1953, the Stanford Research Institute began investigating freight damage claim problems on the Southern Pacific. This led to the joint Stanford-SP invention of the "Hydra-Cushion" underframe to absorb coupling shocks in 1955 (the patent and rights were sold to other manufacturers in 1958).[351] Other innovations in rolling stock at the Sacramento Shops during this period included the following:

- The Hy-Cube car, developed in 1963 to carry high-volume, low-density auto parts such as frames and body panels
- The high-roof car, a boxcar with its roof raised 2.5 feet, first built in 1965 to transport home appliances
- The Sky Box car for large aircraft components like wing and stabilizer assemblies, introduced in 1968

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[350] "Memorial Address," A. J. Stevens Memorial Souvenir, Goode Bros., printers, 1889, CSRM. The monument to Stevens is purported to be one of only five in the United States honoring railroaders. Another, the Judah monument, is also in Sacramento.

[351] Hofsummer, 242.

- The Vert-A-Pac car, developed in 1968 to ship Chevrolet Vegas, which held 30 automobiles fully enclosed in a vertical position
- The Star-Pak car, another fully-enclosed system for larger automobiles, developed in 1972[352]

During this period the shops also developed techniques to ship such unusual cargoes as astronomical observatory telescope mirrors and nuclear reactor vessels for the Rancho Seco power plant. Their isolated location and the fortuitous influx of creative and talented people given free rein to devise their own solutions to the challenges they faced promoted a culture of innovation that allowed the Sacramento Shops to adapt to changing needs, both in designing new railroad equipment and in redesigning themselves.

IN PERSPECTIVE

Because of the varied activities carried out in the shops during the steam era, Central Pacific and Southern Pacific management struggled to implement efficient production methods. The shops' arrangement allowed them to serve the company's myriad

[352] SP *Bulletin* (September/October 1965). SP *Bulletin* (July 1969): 2. SP *Bulletin* (August/September 1970): 7. SP *Bulletin* (November 1970): 3-6.

needs; the complex repaired and maintained locomotives, produced whole new engines, and brought forth improvements and new technologies. It took a flexible arrangement and skilled and knowledgeable craftsmen to support such a system. As such, efficiency and cost cutting were sought in other areas. Thus, themes present in recent analyses of both capital goods and automobile manufacture are reflected here.[353] As in capital goods manufacture—despite the pursuit of more efficient production—rational or assembly-line repair was not achievable in steam locomotive heavy repair shops. Nonetheless, Southern Pacific master mechanics sought efficiency and reduced costs in other ways, such as aggressively developing and adopting technological innovations that not only allowed the railroad to carry heavier freight loads, but also to burn fuel more efficiently. But the introduction of diesel technology would give Southern Pacific the opportunity to not just to change motive power technology, but to streamline—rationalize—its entire

[353] Lindy Biggs, *The Rational Factory: Architecture, Technology, and Work in America's Age of Mass Production* (Baltimore: Johns Hopkins University Press, 1996). Daniel Nelson, *Managers and Workers: Origins of the New Factory System in the United States, 1880-1920* (Madison: University of Wisconsin Press, 1975). David A. Hounshell, *From the American System to Mass Production, 1800-1932: The Development of Manufacturing Technology in the United States* (Baltimore: Johns Hopkins University Press, 1984). On capital goods manufacture, see John K. Brown, *The Baldwin Locomotive Works, 1831-1915* (Baltimore: Johns Hopkins University Press, 1995).

Sacramento heavy repair operation. Surprisingly, and significantly, this was not a step immediately taken.[354]

Diesel engines marked the modern railway, incorporating interchangeable parts, reducing workforces, and standardizing locomotive fleets. Interchangeable parts and standardized designs were ingredients necessary for large-scale, assembly-line repair, but their mere presence did not make the transition to rational production-line repair inevitable. Corporate leaders had to decide to implement such systems, engineers and workers had to develop those systems, and workers had to decide to work within the new system. After all, almost all railroads were dieselizing at the same time, and all companies, having no prior model to adopt, were forced to experimentally devise maintenance techniques for the new locomotives. Initially, Southern Pacific and other railroads tried to fit the new technology in the old heavy repair mold, continuing to use outdated facilities and cumbersome methods to get diesels repaired and back on the road. It took strong proponents within SP to push the company in a whole new direction, as the change would be dramatic, requiring new facilities, substantial capital investment, and new ways of thinking and doing for managers and workers alike.

Yet once SP adopted new industrial engineering and repair methods, the company chose to fit these new processes into old

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[354] Brown. Stephen L. McIntyre, "The Failure of Fordism: Reform of the Automobile Repair Industry, 1913-1940," *Technology and Culture* 41 (April

spaces. Utilizing the Erecting and Machine shops, Blacksmith Shop, and Boiler Shop for many of the overhaul stages, the company added only a new cleaning building, which occupied part of the site of the old roundhouse, one of the few major structures to be demolished. Working new sequential overhaul methods into multiple, older structures meant that the process may not have been as streamlined as might have been possible with the complete razing and rebuilding of the Sacramento facilities. Nonetheless, the system lowered costs and allowed for more systematic heavy maintenance.

Despite a number of standardized diesel designs and the availability of interchangeable parts, SP struggled through the 1950s to develop a rational repair process. When the corporate leadership decided to invest resources in systems engineering and standard quality control procedures, the transition accelerated. Asked why SP took so long to adopt industrial engineering methods that had been widely used elsewhere for decades, workers and engineers alike suggested that it was simply inertia; "it had always been that way." But the company managed to overcome the inertia, and even though SP got a late start in diesel operation and maintenance, the road found itself in an industry-leading position within a decade. Where Southern Pacific engineers had surveyed other railroads' repair practices during the 1950s, the

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2000): 269-299.

company’s new system was so markedly different from standard railroad practice in the 1960s that some of these same railroads sent their engineers to SP’s venerable Sacramento Shops to view the latest innovations in locomotive maintenance.

APPENDIX I - CHRONOLOGY

Events specifically related to the Sacramento Shops are shown in **bold type.**

1855	Construction of a shop begun by Sacramento Valley Railroad on Front Street between P and S streets.
1861	Central Pacific Railroad Company of California (CP) incorporated. City and state granted levee, slough, and lake—site of current shop—to CP.
1862	The Pacific Railway Act authorized construction of the transcontinental railroad.
1863	Construction of CP begun on October 26 at Sacramento.
1865	(First) Southern Pacific Railroad of California (SP) incorporated.
1867	**CP began construction of Sacramento Shops on current site.**
1869	CP meets Union Pacific (UP) at Promontory Summit, Utah, on May 10, completing transcontinental railroad. Transcontinental railroad service begun by UP and CP between Omaha, Nebraska, and Sacramento on May 13. CP's owners purchased Sacramento Valley Railroad. **Roundhouse, 55-foot turntable, and Erecting/Machine Shop completed. Boiler Shop construction begun.**
1870	(Second) Southern Pacific Railroad of California incorporated by "Big Four" (C. P. Huntington, Leland Stanford, Charles Crocker, and Mark Hopkins), giving them control of both CP and SP.
1872	**First new locomotive (CP 173) built in shops.** **Car Shop No. 3 extended to 300 feet in length.** **Paint Shop proposed (and built shortly thereafter).**
1875	**Erecting/Machine Shop lengthened to 400 feet.**
1876	SP and CP passenger cars equipped with air brakes.
1884	(First) Southern Pacific Company (a Kentucky holding company) formed by "Big Four."

1885 SP and CP leased to Southern Pacific Company.

1887 Interstate Commerce Act established the Interstate Commerce Commission (ICC) and federal government regulation of railroads.

1888-90 Shops expanded with Car Machine Shop, Pattern Shop, Paint Shop extension, new Boiler Shop, and 40-foot, steam-powered transfer table.

1893 Safety Appliance Act gave ICC authority to establish standards for safety equipment, including air brakes and automatic couplers, on locomotives and cars.

1896 70-foot turntable installed.
First electric motors installed in shops.

1898 November 16 fire burned Car Machine Shop (1st floor walls survived), and Planing Mill (west and south walls remain). Reconstruction begun immediately.

1901 E. H. Harriman of UP purchased controlling interest in SP (including CP). SP and UP began operating as a single company.

1904 SP reached agreement with city to fill in Sutter's Lake, and city gave SP title to property.

1906 Early steel passenger car (SP 1806) built in shops.
Pacific Fruit Express jointly organized by SP and UP to operate a large fleet of refrigerator cars.

1908 United States vs. Union Pacific, et al. challenged UP control of SP.

1909 SP began operating its first articulated steam locomotive (SP 4000).

1910 44-foot by 544-foot pitless transfer table installed between Erecting Shop and Boiler Shop.

1911 Locomotive Inspection Act gave ICC authority to establish rules and schedules for locomotive boiler inspections. Extended to entire locomotive in 1915.

1913 Supreme Court ruling on United States vs. Union Pacific, et al. ordered UP to sell its SP stock and relinquish control.

1916 **November 26 fire burned eight south bays of Car Shop No. 3, destroying all but eastern wall and southern wall (then attached to the Pattern Shop). Rebuilding continued for over a year.**

1917 Railroads placed under government (United States Railroad Administration) control due to World War I emergency.

1920 Transportation Act returned railroads to private control and gave extensive regulatory authority to ICC.

1921 SP opened new Market Street headquarters in San Francisco.

1922 ICC ruled that acquisition of CP by SP was in the public interest.

1927 **Brick walls of southern half of Blacksmith Shop replaced with reinforced concrete. Old roof structure reused.**

1936 SP began operating a diesel locomotive (twin-unit UP M-10004) on the *City of San Francisco*. Operation of diesels SF-1, SF-2, and SF-3, jointly owned with UP and C&NW, on the *City of San Francisco* began later that year.

1937 **Last new locomotive (SP 1314) built in shops.**

1939 SP began operating its first diesel yard switcher locomotive (SP 1000).

1939-40 **Northern half of Blacksmith Shop rebuilt in reinforced concrete to match the southern half.**

1944 SP subsidiary St. Louis-Southwestern (SSW) began operating its first road freight diesel locomotives (SSW 900, 905, 910, 915, and 920).

1945 **Transfer table enlarged to 70 feet in length.**

1947 (Second) Southern Pacific Company incorporated (in Delaware) after changes in Kentucky law.
SP began operating its first road freight diesel locomotives (SP 6100 - 6119).

1955 Southern Pacific Railroad merged with Southern Pacific Company on September 30.

1958 Last steam locomotive operated on SP main line (SP 4460).

1959 Central Pacific formally merged with Southern Pacific Company on June 30.

1969 General Rehabilitation and Improvement Program (GRIP) begun to refurbish diesel locomotives.

1971 National Rail Passenger Act established Amtrak, which took over operation of most inter-city passenger trains, including those operating over SP.

1976 Railroad Revitalization and Regulatory Reform Act began era of railroad deregulation.

1977 SP tested first double-stack container car (SP 513300).

1978 Pacific Fruit Express separated from SP and UP.

1980 Staggers Act further reduced railroad regulation and expedited the railroad merger application process.

1981 Locomotive repair facility renamed Sacramento Locomotive Works.

1986 Second GRIP locomotive refurbishment program begun.

1988 SP acquired by Rio Grande Industries, the holding company for Denver & Rio Grande Western Railroad (D&RGW). SP and D&RGW functionally combined as Southern Pacific Lines (SPL) in 1989.

1989 Second GRIP locomotive refurbishment program ended.

1995 Interstate Commerce Commission replaced by Surface Transportation Board.

1996 SPL purchased by UP. SP, D&RGW, and other railroads owned by UP functionally combined under UP.

1997 D&RGW formally merged into UP.

1998 SP formally merged into UP.

1999 UP closed Sacramento Shops.

APPENDIX II - PATENTS

Patents issued to Andrew Jackson Stevens, 1855 to 1900

Year	Date	Patent	Description
1861	6/18	32589	Steam balanced valve
1863	7/7	39181	Steam balanced valve
1869	8/10	93494	Steam cultivator
1870	3/15	100814	Steam engine side valve
1871	2/14	111884	Locomotive boiler furnace
1873	12/23	145819	Locomotive furnace
1874	1/20	146617	Vacuum relief valve for steam cylinders
1874	8/25	154529	Balance slide valve
1876	8/8	180956	Flue and tubular boiler
1876	8/22	181370	Steam-moved valve for engines
1877	5/29	191380	Oil and filter cup
1877	7/3	7781	Piston packing (reissue)
1880	7/13	230079	Power steering apparatus for vessels
1880	8/24	231505	Power steering apparatus for vessels
1881	4/5	239877	Friction brake fr steering app fr vessels
1881	4/12	240197	Feed water heater
1881	12/27	9990	Power steering app for vessels (reissue)
1883	11/6	288133	Valve gear for steam engines
1884	9/16	305248	Hoisting crane
1885	8/25	324964	Valve gear for steam engines
1885	11/3	329603	Deflector plate for fireboxes
1885	12/8	331917	Feed water purifier
1886	9/7	348700	Apparatus for burning petroleum
1887	2/8	357424	Balanced slide valve

Patents issued to Stephen Uren, 1870 to 1900

Year	Date	Patent	Description
1880	4/27	226892	Device for forming links
1880	8/31	231693	App for converting scrap into bar steel
1885	10/6	327742	Machine for making nuts
1885	10/6	327743	Utilizing scrap for the mfr of nuts, etc.
1885	12/1	331347	Brake shoe
1889	5/28	404235	Slot mkg attach. fr bolt heading machines
1889	6/4	404580	Slot mkg attach. fr bolt heading machines
1890	5/27	428733	Spike making mechanism

Patents issued to Henry J. Small, 1870 to 1900

Year	Date	Patent	Description
1891	4/28	451138	Snowplow (with T. W. Heintzelman)
1892	4/5	472278	Label holder
1893	8/15	503390	Start app for cpd engines (w/C. T. Noyes)
1893	12/5	510200	Car brake
1897	12/21	595788	App for mfr benzene (with H. Stillman)
1899	3/28	621862	Number displaying device for caboose cars

One patent issued to Benjamin G. Welch, 1870, with assignee.

No patents listed for George Allen Stoddard or C. W. Stevens.

APPENDIX III - GENERAL REHABILITATION AND IMPROVEMENT PROGRAM

The General Rehabilitation and Improvement Program (GRIP) was a complete rebuilding program begun in 1969 for locomotives nearing the end of their useful life. A GRIP unit underwent a complete disassembly, component rebuild, rewiring and reassembly process, plus the installation of modifications to modernize the locomotive. After this 48-day process, these locomotives were expected to be economically serviceable for another 18-20 years.

Locomotive Flow through the GRIP Process

Operation	Location	Notes
Pre-clean	Stripping Shed	1
De-truck	Drop Pit	2
Pre-strip	Erecting Shop	
Wash	Cleaning Track	1
Final strip	Erecting Shop	
Sand blast	Sand Blast Shed	1
Wash	Cleaning Track	1
Pre-fabricate frame	Fabrication Shop	3
Pre-fabricate hood	Fabrication Shop	3
Wash	Cleaning Track	1
Prime paint	Paint Shed	1
Primary reassembly	Erecting Shop	
Re-truck	Drop Pit	2
Final assembly	Erecting Shop	
Paint	Paint Shed	1
Final test and release	Firing Line	4

Notes:

1. This facility was west of the original Boiler Shop building.
2. The drop pit was at the north end of the original Boiler Shop building.
3. This facility occupied the original Boiler Shop building.
4. This facility was a shed just north of the original Boiler Shop building.

ADDENDUM TO: HAER CA-303
SOUTHERN PACIFIC, SACRAMENTO SHOPS *CA-303*
(Central Pacific Railroad Company, Sacramento Shops)
(Southern Pacific Locomotive Works)
111 I Street
Sacramento
Sacramento County
California

REDUCED COPIES OF MEASURED DRAWINGS

FIELD RECORDS

HISTORIC AMERICAN ENGINEERING RECORD
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U.S. Department of the Interior
1849 C Street NW
Washington, DC 20240-0001